No. 607

RANSOM COOK.

$ 1.00

Lafayette

MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

JANUARY—JUNE.

VOL. III.

"We know not how the remark has originated, or what 'philosopher' first claimed for theoretic men any part of the honor of being instrumental, even indirectly, in the perfecting of the Steam Engine; or who gave currency to the phrase of its 'invention being one of the noblest gifts that *science* ever made to mankind!!' The fact is, that science, or scientific men, never had any thing to do in the matter. It was a toy in the hands of all the philosophers who preceded Savery, and it again must become a toy before the speculations of Bossut, the ablest and latest of the philosophers who have written on the subject, can be made to bear upon it. Indeed, there is no machine or mechanism in which the little that theorists have done is more useless. The honor of bringing it to its present state of perfection, therefore, belongs to a different and more useful class. It arose, was improved and perfected, by working mechanics—and by them only; for tradition has preserved to us the fact of Savery having begun life as a working miner;—Newcomen was a blacksmith, and his partner Cawley a glazier;—Don Ricardo Trevithick was also an operative mechanic; and so was the illustrious Watt, when he began, and after he had made his grand improvements."—STUART.

EDITED BY JOHN KNIGHT,

LATE PUBLISHER AND PROPRIETOR OF THE LONDON MECHANICS' MAGAZINE.

NEW-YORK:

PRINTED AND FOR SALE BY THE PROPRIETORS, D. K. MINOR AND J. E. CHALLIS,
No. 35 WALL STREET,

AND TO BE HAD AT THE PRINCIPAL BOOK-STORES.

MDCCCXXXIV.

PREFACE.

The great advantages that are to be gained to the whole "family of mankind" by the spread of useful knowledge among all classes of society, in every part of the globe, must be evident to all who are observers of events, that are continually occurring, either as it regards nations or individuals. We will instance Portugal: if education had been liberally diffused in that country, the people would long ere this have arisen in their moral strength as one man, and shook off those chains imposed upon them by that usurping Tyrant, Don Miguel, who considers the great mass of the people should be kept in ignorance, in order that they may the more easily submit to be the tools of his ambition.

America, as a nation, has much cause to rejoice, that, since she has been declared "free and independent," measures have been taken to increase the facilities for promoting Education. The father of his country, Washington, used his best energies in its behalf; and, when retiring from public to private life, in his farewell address, thus advises his fellow-citizens,—"Promote, as an object of primary importance, institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened." The patriot Jefferson also remarks,—"By far the most *important bill in our own code* is that for diffusing useful knowledge among the people. No other sure foundation can be derived for the preservation of freedom and happiness. Make a crusade against ignorance, establish and improve the law for educating the common people. Let our countrymen know that the people alone can protect us against the evils of aristocratical Europe."

It, then, it is desirable that knowledge should be universally spread, it is the duty of all who feel an interest in its promotion to exert all their energies to accomplish so philanthropic a purpose. In our humble endeavors in this Magazine, we strive to do so, and we call upon its friends and patrons to do their duty, by using their utmost exertions to give it a more extended circulation than it now enjoys. It will promote a more general taste for the cultivation of scientific pursuits; and, by exhibiting some of the pleasures arising from the pursuit of science, engender a wish to dive deeper into it than we profess to do in this Magazine, and incite a desire to consult more regular treatises on particular subjects.

Steam, and Steam Engines, are treated upon to a considerable extent in this volume; but entertaining a similar opinion with the learned Henry Bell, when he states that "he will venture to affirm that history does not afford an instance of such rapid improvement in commerce and civilization as that which will be effected by steam," we have been induced to devote a considerable number of our pages to records of improvements and suggestions respecting it. Such an all-important subject we are satisfied our readers will always turn to with interest, connected as it is with the trade and manufactures of this country.

The recent demise of General Lafayette has presented the opportunity of illustrating this volume with a correct likeness of that good and virtuous man, who was the early and constant friend of America and Americans; and, although not himself a mechanic, did

much for mechanics by lending his powerful aid in establishing a cheap government in this country, where good mechanics are mostly well remunerated for their skill.

In conclusion, we wish to impress upon the minds of our readers the following eloquent remarks of Dr. DICK, in his treatise on the Diffusion of Knowledge: "A man, whose mind is enlightened with true science, perceives throughout all nature the most standing evidences of benevolent design, and rejoices in the benignity of the great Parent of the universe, while he perceives nothing in the arrangement of the Creator, in any department of his works, which has a direct tendency to produce pain to any intelligent or sensitive existence. The superstitious man, on the contrary, contemplates the air, the waters, and the earth, as filled with malicious beings, ever ready to haunt him with terror, or to plot his destruction. The one contemplates the Deity directing the movements of the material world by fixed and invariable laws, which none but himself can counteract or suspend; the other views them as continually liable to be controlled by capricious and malignant beings, to gratify the most trivial and unworthy passions. How very different, of course, must be their conceptions and feelings respecting the attributes and government of the Supreme Being! While the one views him as an infinitely wise and benevolent Father, whose paternal care and goodness inspire confidence and affection, the other must regard him as a capricious being, and offer up his adorations under the influence of fear."

New-York, July 1, 1834.

INDEX.

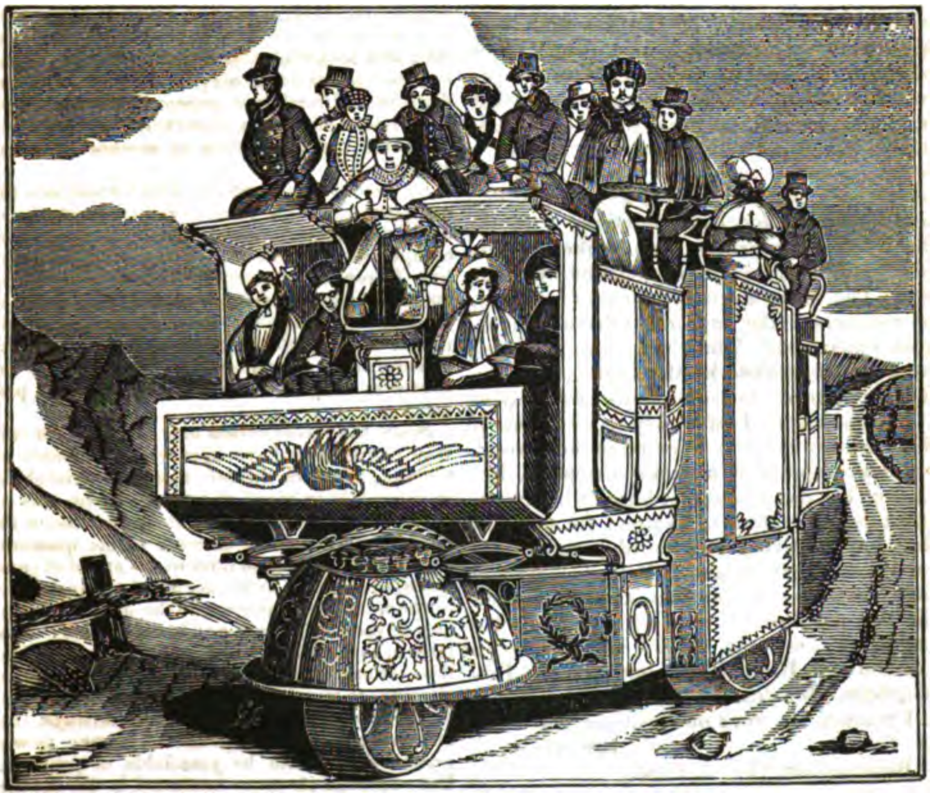
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] JANUARY, 1834. [NUMBER 1.

Whatever tends to enlarge the range of observation, to add to the store of facts, to awaken the reason, and to lead the imagination into agreeable and innocent trains of thought, may assist in the establishment of a sincere and ardent desire for information, and may prepare the way for the reception of more elaborate and precise knowledge, and be as the small optic glass called "the finder," which is placed by the side of a large telescope to enable the observer to discover the star which is afterwards to be carefully examined by the more perfect instrument.—[SOCIETY FOR DIFFUSION OF USEFUL KNOWLEDGE.]



DR. CHURCH'S STEAM CARRIAGE.—We introduce to the notice of our readers a view of a carriage in actual operation in England, with the following remarks from the London Mechanics' Magazine:

In the able article on "Inland Transport," in the Edinburgh Review, said to have been written by Dr. Lardner, Dr. Church's carriage is spoken of as one of the likeliest to be attended with success. Feeling persuaded that you can have no wish but to make the claims of every competitor in this arduous field of mechanical discovery equally known to your numerous readers, and attributing, therefore, to accident entirely, your past neglect of those of Dr. Church, I forward with this a drawing of his engine, in the hope that it may be favored with an early place in your pages, along with the follow-

ing explanatory particulars. The drawing, I should observe, is a reduced copy from a very handsome engraving, recently published here by an artist of the name of Lane.

In the cases of Gurney, Heaton Brothers, and also, I believe, Sir Charles Dance, there is one carriage to carry the engine, and another the passengers. These locomotive machines, in short, are *drags*, merely meant to be used in the same way as Jonathan Hall in the infancy of steam navigation proposed to use steam tugs. Dr. Church, on the contrary, has but one carriage for both machinery and passengers. The one represented in the drawing is built to carry fifty passengers. The wheels are about six inches broad in the tire and eight feet in diameter.

The crank shaft, worked by the cylinders, is connected by endless chains with the axles of the hind wheels of the carriage, and each wheel has a separate axle. The spokes of the wheels are so constructed as to operate like springs to the whole machine—that is, to give and take according to the inequalities of the road. The boiler consists of a series of double tubes, one within the other, placed in a vertical position around a circular fire-place, and communicating with it; the heated air passes through these tubes, which are every where surrounded with water. The tubes are in the form of syphons, to counteract the injurious effects of unequal expansion. The draught is produced by a fanner worked by the engine, and the furnace is made to consume its own smoke.

In conclusion, I have only to add, that, if there be any thing to boast of in the patronage and support of a public company, Dr. Church has more to say for himself in this respect than the Messrs. Heaton; for whereas they have but very late issued proposals for such a company, while it is a considerable time since a company was actually formed for the purpose of working Dr. Church's carriages, not only on the road between London and Birmingham, but between Birmingham, Manchester, and Liverpool.

I remain, sir, your obedient servant,

IMPARTIAL.

Birmingham, Oct. 3, 1833.

Mr. Burden's New Steamboat. By G. [Communicated for the Mechanics' Magazine. and Register of Inventions and Improvements.]

It is interesting to observe, as we sometimes may, how nearly the extremes of the perfection of science, and the early rude essays of art, approximate each other; how often, when the efforts of genius, after long and painful study and experiment, have produced a work which excites wonder and admiration, we may find among some of the earliest and rudest specimens of savage or untutored art, an example of the successful application of the principle by men whose minds were never admitted even to the vestibule of the science, and which has existed in the view of half the world for ages, without ever having been known to arrest the eye of science with reference to the particular principle sought for.

I was led to this remark by the notice I have seen in the Journal of Mr. Burden's newly invented steamboat, the principle of which seems to be so far in advance of all others heretofore known, that perhaps we might conclude that attempts at further improvements would be vain. It is indeed, so far as I can judge from the descriptions I have yet seen, a highly important improvement, and Mr. Burden deserves much credit for his sagacity, enterprize, and perseverance; and the remark with which this article is introduced was far from being designed to detract from the merits of the invention, or the credit of the inventor. It was intended rather to excite attention to the fact, that a careful observation of many of the earliest essays of art may be useful in any endeavors still further to improve this important department of naval architecture, as well as in assisting the researches of science on other subjects.

Of the various elements which enter into the composition of the most perfect specimens of naval architecture, some are, in a degree, incompatible with others. Thus, of the respective forms of construction best adapted for speed, burthen, safety, strength, or power of control, severally, no one can be exclusively given, in its utmost extent, without destroying or essentially impairing the usefulness of the vessel in respect to some other requisite properties.

Since the introduction and extension of railway conveyance have appeared to threaten almost to supersede the use of canals, particularly in cases where *speed* of transportation was an essential object, the attention of a portion of the community has been directed to the question, whether the supposed limit to the speed of canal boats, occasioned by the accumulated resistance of the water in proportion to the increased velocity of the boat, might not be overcome. The laws of matter and motion, however, were confidently supposed to preclude the possibility of success, to any degree which should approach to the velocity already attained on railways, (unless perhaps at an expense of motive power greater than would be justifiable in practice.) But experiments were instituted in Gt. Britain, which soon determined that a speed of at least 15 miles per hour was attainable by a canal boat, with the power of a single horse. (I refer here to experiments on the Ardrossan, and on the Forth and Clyde canals, in 1830.) Later experiments may have produced still higher results, but I do not recollect to have seen any accounts of such. Mr. Burden's experiment, however, seems, so far as we can judge at present, to establish the fact that, by the power of steam, any desirable degree of velocity may be obtained on *smooth* water as easily as on land. The

disparity, therefore, between railway and canal transportations, so far as *velocity* is concerned, appears by this to be immensely diminished, if not perhaps annihilated; and modern science will glory over ignorant antiquity, in the discovery that the resisting power of water is no longer an insuperable impediment to the swiftness of conveyance over its surface.

But let us pause. Making certain degrees of allowance for the facility rendered by the more or less gradual and smooth outline of the curves forming the stem and stern of the boat, the power necessary to propel a vessel through the water is not so much proportioned to the *absolute weight* of the boat, or the quantity of water it displaces, as to the superficial measure of the greatest transverse section of that part of the boat which is immersed in the water. This principle has long been applied to practice in the construction of boats used to ascend our rapid rivers with heavy loads. These have been made as narrow as they would bear without upsetting, or becoming too unsteady for safety; and as long as they would bear without breaking, when they happened to lie aground; perfectly straight on the floor, with as long a rake, fore and aft, as was consistent with convenient management. They were so constructed from the observation of facts, obvious to the eye of the practical boatman, without reference to recondite principles of physical science, because they knew no more of those principles than their effect on the subject matter of their daily occupations. Yet they gained one of the points long sought by science. They transported their loads, ascending against the smooth rapid currents of our rivers, with the least possible expenditure of muscular power, which was the only power then employed; and this point was all they sought. But there were other points not attained in this simple construction. The long flat bottom, and strait "wall sides," were well adapted to easy motion in a direct line forward, in perfectly smooth water, but to move in a curve line was not so easy; and to double a short point, or follow the sinuosities of some of the rivers and streams, without constantly chafing against the banks, would require more power to be exerted laterally, than would be requisite for the *direct* propulsion of the boat in the strongest current. To navigate, also, in *rough* water, the long low-sided boat was unfit: the short waves, not sufficiently broad and gradual to bear up the whole boat, were yet sufficiently high to break over its sides, and fill and sink it.

Mr. Burden's improvement remedies both these disadvantages. The curves of the *bottom*, as well as the sides of his boat, facilitate the steering, and place it under the control of the helm. His *tight deck*, (for so that part of his boat which lies out of the water may be termed,) prevents the filling and sinking of the boat in rough water; though, perhaps, something of its speed in a *direct* line and *smooth* water may be sacrificed by the greater transverse section of the bilge. But this is a minor consideration, compared with its other advantages. The great length, compared with its small transverse section, gives the advantage of increasing the tonnage without increasing the direct resistance to its speed; and the arched form of the whole gives it all the strength which is consistent with other indispensible properties.

But the example of the river-boats, which I have cited, is not the only instance of the successful application *in practice* of principles unknown in *theory*, (unless the practical observations of the untutored savage may be said to be scientific theory in another form.) I have, many years ago, with emotions of surprize and pleasure, watched the rapid gliding of the long, slender, curvilinear forms of the cedar canoes of the Indians navigating the waters of the Oronoke—the apparent ease with which they propelled them with their light paddles—the velocity of their direct movements, and the graceful ease of their steerage. With similar feelings I have seen and navigated the light birch bark canoe of the Indians of the Penobscot. Their speed—ease of propulsion—facility of evolutions—safety, in *skilful*, yet fragility and danger in *unskilful*, hands,—have long been a theme of admiration to those to whom familiarity has not rendered the sight indifferent. These, with those of the Oronoke, and other parts of the south, and, as far as I can judge from the descriptions I have seen, the astonishingly swift *pirogues* of the South Sea Islanders, are all actually formed, *at and below their water-line*, substantially on the principle of Mr. Burden's *parabolic spindle!* The savage fashions his rude bark in the form which the *experience* of his forefathers has taught him was best adapted to obtain the ends desired—speed, safety, and ease of evolution, so far as circumstances would admit of their combination. But one thing more was wanting: the least possible width to the boat was necessary to diminish the resistance of the water to its rapid flight; but this rendered it too liable to be upset. To remedy this, the "outrigger," and the "double-canoe" of the South Seas, appear. These perhaps may have afforded the hint for the "*twin boat*," introduced but a few years ago on the Forth and Clyde canal—and now to the latter succeeds, *on the same radical principle*, the "*twin parabolic spindle raft*" (if I may be allowed to coin the appellation) of Mr. Burden. * * *

It is yet to be ascertained whether Mr. Burden's boat will prove as valuable an improvement in navigating the ocean, as it appears to be in the mode of river and canal navigation. Its "tight deck" gives it, in some respects, the advantage over its partial prototype, the Indian canoe; but, for *some* purposes, the form of the latter may be preferred. It may, also, at present be doubted, whether the extreme length of the projecting part of the "spindle," level with the surface of the water, may not, in *ocean* navigation, expose it so much to the power of the waves as to impede its motion and endanger its safety, more than sufficient to counterbalance its other advantages. But this is only the precautionary suggestion of ignorance; and I would not, by any means, utter it to damp the ardor of inventive improvement, or

diminish the credit due to the experiment thus far. Mr. Burden will doubtless be stimulated by his present success, to study still farther improvements; and will not, I am sure, impute the observations I have made to any unfriendly spirit. They are made on the spur of the moment, under the influence of real pleasure at the annunciation I have just seen of his experiment, and a disposition to contribute my mite towards bringing to view any such facts in the history of the arts as may afford any lessons or hints useful to the cause of general improvement. The facts I have alluded to prove, at least, that one part of Mr. Burden's principle—the form of his boat below the water-line—is a sound one; that it has stood the test of long experiment. With respect to the other part—the unity of the whole to prevent the dangers, in rough water, of almost constant submersion—perhaps the "*kajak*" of the Greenlander may afford an analogy of *some* importance. So that, on the whole, should Mr. Burden's first experiment fail, or come short of *complete* success, he will have the support of long-tried facts to sustain him in asserting the soundness of the *principles;* and need only to direct his attention to such improvements as may be necessary in the *details*, to make his invention complete in *all* respects. Every American—indeed, every friend to the success of rightly-directed enterprize and the improvement of the condition of man—must cordially wish him success. G.

Animal Mechanics, or Proofs of Design in the Animal Frame. [From the Library of Useful Knowledge.]

INTRODUCTION.

To prepare us for perceiving design in the various internal structures of an animal body, we must first of all know that perfect security against accidents is not consistent with the scheme of nature. A liability to pain and injury only proves how entirely the human body is formed with reference to the mind; since, without the continued call to exertion, which danger and the uncertainty of life infer, the developement of our faculties would be imperfect, and the mind would remain, as it were, uneducated.

The contrivances (as we should say of things of art,) for protecting the vital organs, are not absolute securities against accidents; but they afford protection in that exact measure or degree calculated to resist the shocks and pressure to which we are exposed in the common circumstances of life. A man can walk, run, leap, and swim, because the texture of his frame, the strength and power of his limbs, and the specific gravity of his body, are in relation with all around him. But were the atmosphere lighter, the earth larger, or its attraction more—were he, in short, an inhabitant of another planet,—there would be no correspondence between the strength, gravity, and muscular power of his body, and the elements around him, and the balance in the chances of life would be destroyed.

Without such considerations the reader would fall into the mistake that weakness and liability to fracture imply imperfection in the frame of the body, whereas a deeper contemplation of the subject will convince him of the incomparable perfection both of the plan and of the execution. The body is intended to be subject to derangement and accident, and to become in the course of life more and more fragile, until, by some failure in the frame-work or vital actions, life terminates.

And this leads us to reflect on the best means of informing ourselves of the intention or design shown in this fabric. Can there be any better mode of raising our admiration than by comparing it with things of human invention? It must be allowed, that we shall not find a perfect analogy. If we compare it with the forms of architecture—the house or the bridge are not built for motion, but for solidity and firmness, on the principle of gravitation. The ship rests in equilibrium prepared for passive motion, and the contrivances of the ship-builders are for resisting an external force: whilst in the animal body we perceive securities against the gravitation of the parts, provisions to withstand shocks and injuries from without, at the same time that the frame-work is also calculated to sustain an internal impulse from the muscular force which moves the bones as levers, or, like a hydraulic engine, propels the fluids through the body.

As in things artificially contrived, lightness and motion are balanced against solidity and weight, it is the same in the animal body.

A house is built on a foundation immoveable, and the slightest shift of the ground, followed by the ruin of the house, brings no discredit on the builder; for he proceeds on the certainty of strength from gravitation on a fixed foundation. But a ship is built with reference to motion, to receive an impulse from the wind, and to move through the water. In comparison with the fabric founded on the fixed and solid ground, it becomes subjected to new influences, and in proportion as it is fitted to move rapidly in a light breeze, it is exposed to founder in the storm. A log of wood, or a Dutch dogger, almost as solid as a log, is comparatively safe in the trough of the sea during a storm—when a bark, slightly built and fitted for lighter breezes, would be shaken to pieces: that is to say, the masts and rigging of a ship (the provisions for its motion) may become the

source of weakness, and, perhaps, of destruction; and safety is thus voluntarily sacrificed in part, to obtain another property of motion.

So in the animal body: sometimes we see the safety of parts provided for by strength calculated for inert resistance; but when made for motion, when light and easily influenced, they become proportionally weak and exposed, unless some other principle be admitted, and a different kind of security substituted for that of weight and solidity: still a certain insecurity arises from this delicacy of structure.

We shall afterwards have occasion to shew that there is always a balance between the power of exertion and the capability of resistance in the living body. A horse or a deer receives a shock in alighting from a leap; but still the inert power of resisting that shock bears a relation to the muscular power with which they spring. And so it is in a man: the elasticity of his limbs is always accommodated to his activity; but it is obvious, that in a fall, the shock, which the lower extremities are calculated to resist, may come on the upper extremity, which, from being adapted for extensive and rapid motion, is incapable of sustaining the impulse, and the bones are broken or displaced.

The analogy between the structure of the human body and the works of human contrivance, which we have to bring in illustration of the designs of nature, is, therefore, not perfect; since sometimes the material is different, sometimes the end to be attained is not precisely the same; and, above all, in the animal body a double object is often secured by the structure or frame-work, which cannot be accomplished by mere human ingenuity, and of which, therefore, we can offer no illustration strictly correct.

However ingenious our contrivances may be, they are not only limited, but they present a sameness which becomes tiresome. Nature, on the contrary, gives us the same objects of interest, or images of beauty, with such variety, that they lose nothing of their influence and their attraction by repetition.

If the reader has an imperfect notion of design and providence, from a too careless survey of external nature, and the consequent languor of his reflections, we hope that the mere novelty of the instances we are about to place before him may carry conviction to his mind; for we are to draw from nature still, but in a field which has been left strangely neglected, though the nearest to us of all, and of all the most fruitful.

Men proceed in a slow course of advancement in architectural, or mechanical, or optical sciences; and when an improvement is made, it is found that there are all along examples of it in the animal body, which ought to have been marked before, and which might have suggested to us the improvement. It is surprizing that this view of the subject has seldom, if ever, been taken seriously, and never pursued. Is the human body formed by an all-perfect Architect, or is it not? And, if the question be answered in the affirmative, does it not approach to something like infatuation, that possessing such perfect models as we have in the anatomy of the body, we yet have been so prone to neglect them?

We undertake to prove that the foundation of the Eddystone lighthouse, the perfection of human architecture and ingenuity, is not formed on principles so correct as those which have directed the arrangement of the bones of the foot; that the most perfect pillar or kingpost is not adjusted with the accuracy of the hollow bones which support our weight; that the insertion of a ship's mast into the hull is a clumsy contrivance, compared with the connections of the human spine and pelvis; and that the tendons are composed in a manner superior to the last patent cables of Huddart, or the yet more recently improved chain-cables of Bloxam.

Let us assume that the head is the noblest part; and let us examine the carpentry and architectural contrivances exhibited there.

But before we give ourselves up to the interest of this subject, it will gratify us to express our conviction, that the perfection of the plan of animal bodies, the demonstration of contrivance and adaptation, but more than these, the proof of the continual operation of the power which originally created the system, are evinced in the property of life,—in the adjustment of the various sensibilities,—in the fine order of the moving parts of the body,—in the circulation of living blood,—in the continual death of particles, and their removal from the frame,—in the permanence of the individual whilst every material particle of his frame is a thousand times* changed in the progress of his life. But this is altogether a distinct inquiry, and we are deterred from touching upon it, not more from knowing that our readers are not initiated into it,

* The old philosophers gave out that the human body was seven times changed during the natural life. Modern discoveries have shewn that the hardest material of the frame is changing continually; that is, every instant of time from birth to death.

than from the depth and very great difficulty of the subject.

CHAPTER I.

ARCHITECTURE OF THE SKULL.—It requires no disquisition to prove that the brain is the most essential organ of the animal system, and being so, we may presume that it must be especially protected. We are now to inquire how this main object is attained?

We must first understand that the brain may be hurt, not only by sharp bodies touching and entering it, but by a blow upon the head, which shall vibrate through it, without the instrument piercing the skull. Indeed, a blow upon a man's head, by a body which shall cause a vibration through the substance of the brain, may more effectually deprive him of sense and motion, than if an axe or a sword penetrated into the substance of the brain itself.

Supposing that a man's ingenuity were to be exercised in contriving a protection to the brain, he must perceive that if the case were soft, it would be too easily pierced; that if it were of a glassy nature, it would be chipped and cracked; that if it were of a substance like metal, it would ring and vibrate, and communicate the concussion to the brain.

Further thoughts might suggest, that whilst the case should be made firm, to resist a sharp point, the vibrations of that circular case might be prevented by lining it with a softer material; no bell would vibrate with such an incumbrance—the sound would be stopped like the ringing of a glass by the touch of a finger.

If a soldier's head be covered with a steel cap, the blow of a sword which does not penetrate will yet bring him to the ground by the percussion which extends to the brain; therefore, the helmet is lined with leather, and covered with hair, for, although the hair is made an ornament, it is an essential part of the protection: we may see it in the head-piece of the Roman soldier, where all useless ornament, being despised as frivolous, was avoided as cumbrous.

We now perceive why the skull consists of two plates of bone, one external, which is fibrous and tough, and one internal, dense to such a degree that the anatomist calls it *tabula vitrea* (the glassy table).

Nobody can suppose this to be accidental. It has just been stated that the brain may be injured in two ways: a stone or a hammer may break the skull, and the depressed part of the bone injure the brain; whilst, on the other hand, a mallet struck upon the head will, without penetrating, effectually deprive the brain of its functions, by causing a vibration which runs round the skull, and extends to every portion of its contents.

Were the skull, in its perfect or mature state, softer than it is, it would be like the skull of a child; were it harder than we find it is, it would be like that of an old man. In other words, as in the former it would be too easily pierced, so in the latter it would vibrate too sharply and produce concussion. The skull of an infant is a single layer of elastic bone; on the approach to manhood it separates into two tables; and in old age it again becomes consolidated. During the active years of man's life the skull is perfect: it then consists of two layers, united by a softer substance; the inner layer is brittle as glass, and calculated to resist any thing penetrating; the outer table is tough, to give consistence, and to stifle the vibration which would take place if the whole texture were uniform and like the inner table.

The alteration in the substance of the bones, and more particularly in the skull, is marvellously ordered to follow the changes in the mind of the creature, from the heedlessness of childhood to the caution of age, and even the helplessness of superannuation.

The skull is soft and yielding at birth; during childhood it is elastic, and little liable to injury from concussion; and during youth, and up to the period of maturity, the parts which come in contact with the ground are thicker, whilst the shock is dispersed towards the sutures (the seams or joinings of the pieces,) which are still loose. But when, with advancing years, something tells us to give up feats of activity, and falls are less frequent, the bones lose that nature which would render concussion harmless, and at length the timidity of age teaches man that his structure is no longer adapted to active life.

We must uuderstand the necessity of the double layer of the skull, in order to comprehend another very curious contrivance. The sutures are the lines of union of the several bones which form the *cranium**, and surround and protect the brain. These lines of union are called *sutures*, (from the Latin word for *sewing*,) because they resemble seams. If a workman were to inspect the joining of two of the bones of the cranium, he would admire the minute dovetailing by which one portion of the bone is inserted

* *Cranium*, from a Greek word, signifying a helmet. The cranium is the division of the skull appropriated to the protection of the brain; it consists of six bones—the *frontal* (or forehead); two *parietal* (walls or side bones); the *occipital* (back of the head); and two *temporal* (or temple) bones.

into, and surrounded by, the other, whilst that other pushes its processes or juttings out between those of the first in the same manner, and the fibres of the two bones are thus interlaced, as you might interlace your fingers. But when you look to the internal surface, you see nothing of this kind; the bones are here laid simply in contact, and this line by anatomists is called *harmonia*, or harmony. Architects use the same term to imply the joining by masonry. Whilst the anatomists are thus curious in names, it is provoking to find them negligent of things more interesting. Having overlooked the reason of the difference in the tables of bones, they are consequently blind to the purpose of this difference of the outward and inward part of a suture.

Suppose a carpenter employed upon his own material, he would join a box with minute and regular indentations by dovetailing, because he knows that the material on which he works, from its softness and toughness, admits of such adjustment of its edges. The processes of the bone shoot into the opposite cavity with an exact resemblance to the foxtail wedge of the carpenter—a kind of tenon and mortice when the pieces are small.

But if a workman in glass or marble were to inclose some precious thing, he would smooth the surfaces and unite them by cement, because, even if he could succeed in indenting the line of union, he knows that his material would chip off on the slightest vibration. The edges of the marble cylinders which form a column are, for the same reason, not permitted to come in contact; thin plates of lead are interposed to prevent the edges, technically termed *arrises*, from chipping off or splitting.

Now apply this principle to the skull. The outer softer tough table, which is like wood, is indented and dove tailed; the inner glassy table has its edges simply laid in contact. It is mortifying to see a course of bad reasoning obscure this beautiful subject. They say that the bone growing from its centre, and diverging, shoots its fibres betwixt those which come in an opposite direction; thus making one of the most curious provisions of nature a thing of accident. Is it not enough to ask such reasoners, why there is not a suture on the inside as well as on the out?

The junction of the bones of the head generally being thus exact, and like the most finished piece of cabinet work, let us next inquire, whether there be design or contrivance shown in the manner in which each bone is placed upon another.

Fig. 1.

A, the parietal bone; B, the frontal bone; C, the occipital bone; D, the temporal bone; E, the sphenoid bone.

When we look upon the side of the skull thus, the temporal suture betwixt the bones A and D is formed in a peculiar manner; the lower or temporal bone laps over the superior or parietal bone. This, too, has been misunderstood: that is to say, the plan of the building of the bones of the head has not been considered, and this joining, called the squamous* suture, which is a species of scarfing, has been supposed a mere consequence of the pressure of the muscle which moves the jaw.

Dr. Monro says, "the manner how I imagine this sort of suture is formed at these places, is that, by the action of the strong temporal muscles on one side, and by the pressure of the brain on the other, the bones are made so thin that they have not large enough surfaces opposed to each other to stop the extension of their fibres in length, and thus to cause the common serrated appearance of sutures; but the narrow edge of the one bone slides over the other."

The very name of the bones might suggest a better explanation. The *ossa parietalia*† are the two large bones in a regular square, serving as walls to the interior, or room of the head, where the brain is lodged. (See A, in the foregoing figure.)

Did the reader ever notice how the walls of a house are assisted when thin and overburdened with a roof?

The *wall plate* is a portion of timber built into the wall, to which a transverse or tie-beam is attached by carpentry. This *cogging*, as it is termed, keeps the wall in the perpendicular, and prevents any lateral pressure of the roof.‡ We sometimes see a more clumsy contrivance, a clasp, or a round plate of iron, upon the side of a wall; this has a screw going into the ends of a cross-

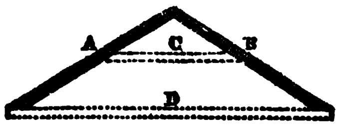
* From *squama*, the Latin for a *scale*, the thin edges lying over each other like the scales of a fish.

† From the Latin word *paries*, a wall.

‡ In the second Treatise on Heat, the reader will find an account of the manner in which the expansion of iron by heat, and its subsequent contraction on cooling, is used in order to cog great buildings.

beam, and by embracing a large portion of the brick-work, it holds the wall from shifting at this point. Or take the instance of a roof supported on inclined rafters A B:

Fig. 2.

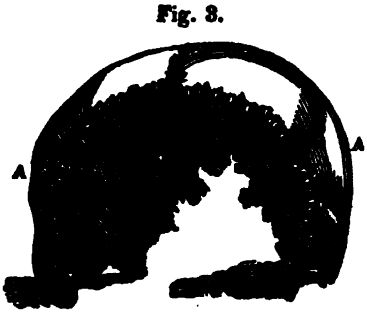


Were they thus, without further security, placed upon the walls, the weight would tend to spur or press out the walls, which must be strong and heavy, to support the roof; therefore the skeleton of the roof is made into a *truss*, (for so the whole joined carpentry is called.) The upper cross-beam, marked by the dotted lines C, is a collar-beam, connecting the rafters of the roof, and stiffening them, and making the weight bear perpendicularly upon the walls. When the transverse beam joins the extremities of the rafters, as indicated by the lower outline, D, it is called a *tie-beam*, and is more powerful still in preventing the rafters from pushing out the walls.

Now, when a man bears a burden upon his head, the pressure, or horizontal push, comes upon the lower part of the *parietal bones*, and if they had not a tie-beam, they would in fact be spurred out, and the bones of the head be crushed down. But the temporal bone, D, and still more, the sphenoid bone, E, by running across the base of the skull, and having their edges lapping over the lower part of the great walls, or the parietal bones, lock in the walls as if they had iron plates, and answer the purpose of the tie-beam in the roof, or the iron plate in the walls. But the connection is at the same time so secure, that these bones act equally as a *straining* piece, that is, as a piece of timber, preventing the tendency of the sides *of the skull* to each other.

It may be said, that the skull is not so much like the wall of a house as like the arch of a bridge: let us then consider it in this light.

Fig. 3.



We have here the two parietal bones, separated and resting against each other, so as to form an arch. In the centering, which is the wooden frame for supporting a stone arch while building, there are some principles that are applicable to the head.

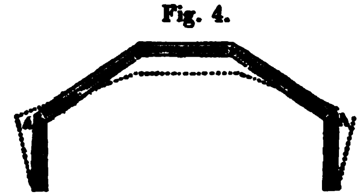
We see that the arch formed by the two parietal bones is not a perfect semi-circle; there is a projection at the centre of each bone: the bone is more convex, and thicker at this part.

The cause assigned for this is, that it is the point from which ossification begins, and where it is, therefore, most perfect. But this is to admit a dangerous principle, that the forms of the bones are matter of chance; and thence we are left without a motive for study, and make no endeavor to comprehend the uses of parts. We find that all the parts which are most exposed to injury are thus strengthened: the centre of the forehead, and the projecting point of the skull behind, and the lateral centres of the parietal and frontal bones. The parts of the head which would strike upon the ground when a man falls are the strongest, and the projecting arch of the parietal bone is a protection to the weaker temporal bone.

If we compare the skull to the *centering*, where a bridge is to be built over a navigable river, and consequently where the space must be free in the middle, we find that the scientific workmen are careful, by a transverse beam, to protect the points where the principal thrust will be made in carrying up the masonry. This beam does not act as a tie-beam, but as a straining-piece, preventing the arch from being crushed in at this point.

The necessity of strengthening certain points is well exhibited in the carpentry of

Fig. 4.



roofs. In this figure it is clear that the points A A will receive the pressure of the roof, and if the joining of the puncheons* and rafters be not secure, it will sink down in the form of the dotted line. The workmen would apply braces at these angles to strengthen them.

In the arch, and at the corresponding points of the parietal bones, the object is at-

* The puncheons are the upright lateral pieces; the rafters are the timbers which lie oblique, and join the puncheons at A A.

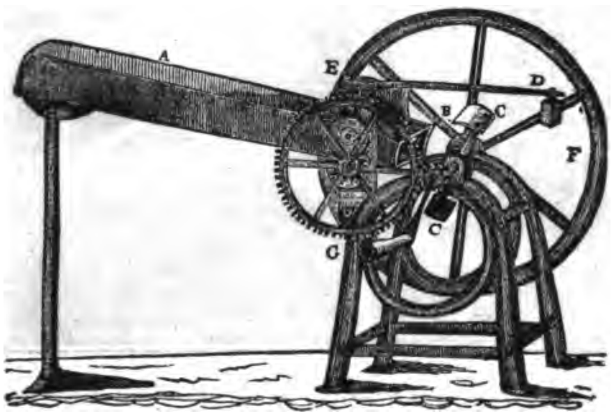
tained by strengthening these points by increase of their convexity and thickness; and where the workman would support the angles by braces, there are ridges of bone in the calvaria,* or roof of the skull.

If a stone arch fall it must give way in two places at the same time; the centre cannot sink unless that part of the arch which springs from the pier yields; and in all arches, from the imperfect Roman arch to that built upon modern principles, the aim of the architect is to give security to this point.

In the Roman bridges still entire, the arch rises high, with little inclination at the lower part; and in bridges of a more modern date, we see a mass of masonry erected on the pier, sometimes assuming the form of ornament, sometimes of a tower or gateway, but obviously intended at the same time, by the perpendicular load, to resist the horizontal pressure of the arch. If this be omitted in more modern buildings, it is supplied by a finer art, which gives security to the masonry of the pier, (to borrow the terms of anatomy,) by its internal structure.

In what is termed Gothic architecture, we see a flying buttress springing from the outer wall, carried over the roof of the aisle, and abutting against the wall of the upper part, or *clere-story*. From the upright part of this masonry, a pinnacle is raised, which at first appears to be a mere ornament, but which is necessary, by its perpendicular weight, to counteract the horizontal thrust of the arch.

* From the Latin *calva* or *calvaria*, *a helmet*.



Improved Straw and Hay Cutting Machine. [From the Edinburgh Quarterly Journal of Agriculture.]

The annexed cut exhibits one of these improved machines, as manufactured by Messrs. Slight and Lillie, with the framing made entirely of cast iron. A is the feeding-trough, the rollers being only partially seen. B is the nozzle or cutting-box. C C, the cutter-bearers, with the cutters attached by their bolts. D is a lever and weight, which, through the medium of the bridge E, keeps a constant pressure on the feeding-rollers, to counteract any inequality of feeding. F is the fly-wheel for equalizing the motion; and G, the handle to which the power is applied. The small pinion on the fly-wheel shaft gives motion to the spur-wheel, which is mounted on the shaft of the lower feeding-roller, and carries also the lower feeding-pinion. This last pinion works into the pinion of the upper roller, and both being furnished with very long teeth, they thereby admit of a limited range of distance between the rollers, according to the quantity of feed.

With one of these machines, a man, assisted by a boy to feed in the hay or straw, can cut at the rate of eight stones per hour; and that quantity of cut hay is found to be sufficient for sixteen horses for twenty-four hours.

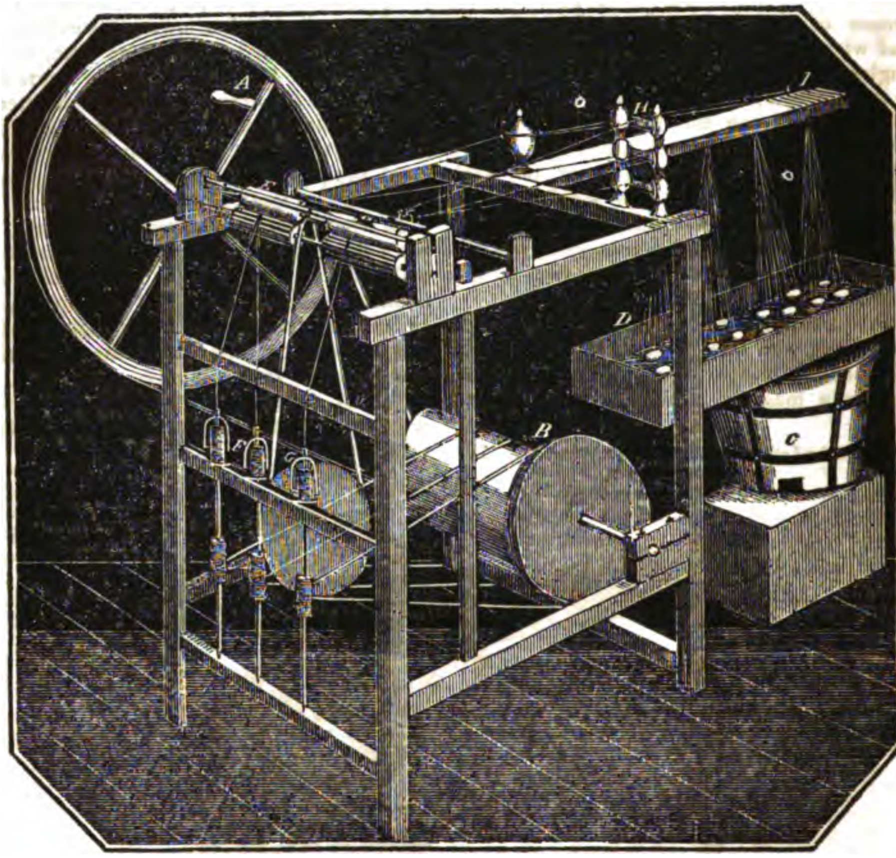
The machine, of which the above is a figure and description, combines, in an eminent degree, expedition and efficiency, with ease to the workman. We do not think it can be made of a simpler construction.

Manufacture of Silk—Reeling, Twisting from the Cocoon—Description and Drawing of Brooks' Silk Machine. [From the New-York Farmer.]

The manufacture of silk is so likely to become an important branch of national industry, that we deem it important to lay before our readers all the information that we can obtain.

On the present occasion, we shall simply state the particulars of an experiment with Mr. Adam Brooks' machine.

After considerable inquiry for cocoons in this section of the country, we were enabled to obtain a bushel that had been, two years ago, sent on to this city, from one of the Southern States, for a market. In consequence of there being no demand for them, they had been put aside as a



worthless article. They were in a box rendered tight by paper pasted over the openings at the joinings of the boards. Some of the cocoons were perforated by an insect not unlike the common moth; but generally they were in excellent order.

All the practical information we had had, was from seeing Mr. Brooks exhibit his machine in operation a few times. In connection with another person, whose opportunities of practical knowledge were no greater than our own, we took a peck of the cocoons, 485 in number, and weighing ten ounces. Without assorting them, as we should have done, we put a handful of some 20 or 40 into water about boiling hot—took a small broom and pressed them into the water—found the floss silk adhering to the broom—gathered the silk from the broom, and kept drawing the silk until a fibre ran off singly and evenly from each cocoon—lifted these running cocoons from the water with an instrument not half so convenient as a skimmer, and placed them in a winding basin partly filled with heated water—served other cocoons in the same manner until we acquired two threads of about 100 fibres or cocoons, and carried the threads through the guide wires, between the rollers, to the bobbins. Thus prepared, we began to wind by turning the wheel, keeping up the thickness of the thread by supplying additional cocoons, and collecting and attaching the ends of those that had broken. After a sufficient quantity was on the bobbins, took them and placed them in the upright posts, and carried the ends through the guides and rollers to the bobbin, for the purpose of doubling and twisting. Replacing the bobbins with two more, we then, by turning the wheel, wound, doubled, and twisted the silk at one operation. Thus continuing, we obtained from the peck $1\frac{1}{4}$ ounces of fine sewing silk, which, when deprived of the gum, by being several times boiled in soap suds, weighed one ounce. Besides this, there were $4\frac{1}{4}$ ounces of floss silk obtained from the gathering of the silk from the broom, from cocoons that would not wind, and from those that had been injured by insects, or imperfectly formed. These $4\frac{1}{4}$ ounces, after having been cleansed in soap suds, weighed 3 ounces. This floss silk is to be carded and spun for stockings and other purposes.

The sewing silk being very fine, did not, owing to the improper adjustment of the machine, give a sufficient twist; in other respects it was pronounced a fair, saleable article. When it is considered that we were entirely *green* at the business, were several times obliged, as soon as we got into operation, to omit our labors for

another day, and were not in possession of the conveniences for producing a good article, our readers will perceive that the manufacture of silk for common domestic purposes is not more difficult than to spin flax or wool, which was formerly done by the females of almost every farmer's family in the country.

Our lowest estimate of the value of the bushel when made into sewing and floss silk, is $4,50. Our information, however, relative to its price, is derived from books and personal inquiries, and is extremely varied, and often contradictory. One thing is very certain, that if $2 50 to $3 50 per bushel for the cocoons is a remunerating price to the farmer, the manufacture of them into silk in his own family must be very profitable.

The machine, the drawing of which accompanies this article, is the invention of Mr. Adam Brooks, of Scituate, Mass. It is admirably adapted for families, when sewing silk is intended to be made. The one we used is a beautiful machine, made of mahogany, in a substantial and workmanlike manner. It cost $28. Those of hard but less costly wood, and thoroughly made, are $25. With an additional bobbin, $30 and $26.

Machines made by the inventor may be had of the agents, H. Huxley and Co. 81 Barclay street

REFERENCES.—A, the handle of the crank, giving motion to the machine. There is a band around the large wheel, passing around a small wheel attached to the axis of the cylinder or drum. B, the drum or cylinder, around which the bands giving motion to the spindles pass. C, the furnace for heating to blood heat the water in the pan D, containing the cocoons. E, the rollers regulating the supply of thread given to the spindles. F, the two spindles for twisting the single threads. G, the spindle for the double twisting or sewing silk. H, the two upright pillars supporting the bobbins containing the single thread to be double twisted. J, a projecting slat, containing the leading wires to receive the threads from the cocoons in the pan D.

MANUAL LABOR SCHOOL.—The first self-supporting school in the United States was opened in May of 1813, in Derby, at the head of navigation on the Housatonic river, in Connecticut. It continued eight years, during which time about twenty lads paid all their expenses for board, clothes, tuition, and books. At the time this school was opened, public sentiment was almost unanimously against it. The common remark was, that "it was good in theory, but could not be put in practice."

STEAMBOAT NEW-ENGLAND.—We are induced to insert the annexed testimony of the witnesses examined respecting the bursting of the boilers of the New-England, notwithstanding its length, on account of the importance of the general subject to which it relates, the melancholy interest connected with the case immediately under consideration, and the high scientific reputation of the gentlemen composing the Board of Examiners. Public opinion had assigned a *deficiency of water* as the cause of the explosion; but the Committee, after the most careful investigation, are unanimous in the belief that it was "the pressure of steam produced *in the ordinary way*, but accumulated to a degree of tension which the boilers were unable to sustain."

Alexander Marshall, Engineer—Was engineer of the steamboat New-England, on the 8th October last. Left New-York a few minutes after 4 P. M., on that day, with a light pressure of steam. The engine having been started cold, the steam did not increase till we had proceeded as far as Hurlgate.

The average pressure used on the passage was from 10 to 12 inches. The steam rose after starting from 8 to 14 or 16 inches. At 7 P. M., left the engine in charge of Mr. Younger, the assistant engineer, and retired to rest with a view of taking his watch at 10 P. M. Was called by Mr. Younger at 10 o'clock. There was a heavy sea in the sound, and, in consequence of orders which Capt. Waterman had given, the steam was reduced to 8 or 9 inches. Was obliged to stop before arriving in the river by order of the pilot, in order to adjust the wheelrope. Arrived in the river about 1 o'clock A. M. Missed the wharf at Saybrook, and after a second attempt to gain the wharf, some difficulty occurred with the lifting valves, in consequence of the binders by which they are confined being screwed too tight, which made it necessary to anchor. After loosening the valve rods, the boat got under way, and landed at Saybrook. Landed also at Lyme. Just before landing at Essex, went into fire-room and examined the gauge-cocks (water-cocks,) and found the water good in the boilers. This was three or four minutes previous to the explosion. The boat was stopped about two minutes at Essex to land a passenger, with the small boat. Took hold of the pulley of the safety valve for the purpose of raising it, and at this moment the explosion took place. Does not know whether he had lifted the valve or not.

Being further examined, he says, that the steam-gauge did not exceed 14 inches while in the sound nor 10 inches after entering the river. This statement is not founded on actual measurement. There was no scale of inches marked to either of the steam-gauges. Refers only to the height of his own gauge in the engine-room. Is aware that the steam-gauges in the two fire-rooms ranged considerably higher. Ascribes the difference to the greater expansion of the mercury in the fire-rooms, from the proximity to the fire. Had a greater pressure of steam immediately previous to the explosion than was proper to use in the river, where the boat does not steer well under a strong power, and this was the reason why witness attempted to raise the safety valve.

Witness further says, that the New-England commenced her first trip on the 30th August last, under the charge of witness as engineer, he having been employed to set up the engine. The charge of the engine was afterwards given to Mr. Potter, the engineer of the company who owned the boat.

Witness again took charge of the engine on the trip previous to that on which the accident occurred, in consequence of the illness of Mr. Potter. Witness was employed as engineer of a steamboat at the South, 12 years ago, which boat was run by him during the season of navigation. Says that his management on the night of the accident was not at any time influenced by a desire to shorten the passage. Heard no inquiry made by any of the passengers about racing. The only fuel used by him in the New-England was pine wood. Witness has been 20 years engaged in his present business. Has served a regular apprenticeship in the manufacture of engines. Has been employed in New-York by Mr. M'Queen, Mr. Allaire, Mr. Sabbatton, and the West-Point Foundry Association.

The safety valve of the New-England was loaded 18 pounds in the square inch, and its position on the steam pipe is 20 feet, or more, from the boilers. Besides two regular weights on the safety valve, there were two extra weights, a 50, and a 28. The valve will blow off at 8 pounds to the square inch, with the two regular weights. This is owing to the lever of the safety valve having been shortened about 2 feet, to bring it within the walls of the room by which it is enclosed. The diameter of the safety valve is 10½ inches. The diameter of the steam pipes which lead from the boiler is about 10 inches.

Robert Younger, Assistant Engineer.—Witness started from New-York at a few minutes past 4 o'clock P. M., as assistant to Marshall. At 7 P. M., Marshall left the engine in charge of witness. About half past 8, Capt. Waterman came to the engine-room and asked if the engine did not labor too much in the sea. Also inquired the height of the steam-gauge; was answered 10 inches. Capt. Waterman requested him not to carry any more. Witness then blew off steam, and went to the fire-room and gave directions for less fire. Run with steam from 8 to 10 inches, till Mr. Marshall came on deck at 10 o'clock. Witness examined the water in the boilers frequently on the passage. Did not see the height of the steam-gauge for the last 10 or 15 minutes previous to the explosion, because his view of the gauge while standing at his post in the engine-room was obstructed by an appendage to the steam-pipe. There was no difficulty occurred in the management of the water in the boilers. One of the boilers foamed once while Mr. Marshall was below. This was immediately stopped by putting oil into the force pump. The steam was blown off at Saybrook while lying to for the purpose of loosening the binders of the lifting rods. This was before landing at Saybrook Point. The position of the bulk-head did not prevent the raising of the safety valve. Witness saw the moveable part of the bulk-head in its proper place on the morning after the accident. Is certain of this from his own personal examination. Has never witnessed an accident of this kind before. Has been 12 years engaged in the business of making engines. Made his first trip as an acting engineer in the New-England when the boat was first started. Assisted Marshall in fitting up the engine. Thinks that there was no want of water above the flues, but is of opinion that the steam had blown the water from the legs of the boilers.

William Vail, Pilot.—Says that the New-England left New-York at 12 minutes past 4 P. M. in company with the steamboat General Jackson. The steamboat Boston left the wharf soon after the New-England. The Boston gained upon the New-England till they reached Hurlgate. The New-England then got more steam on, and drew away from the Boston. Found a heavy sea in the Sound, after passing Sands' Point, and the Boston then preserved her distance. The New-England steers very badly. After passing Falkner's Island, the wheelrope got foul, and detained us a few minutes, and the boat fell into the trough of the sea. Off Killingworth, and again off Duck Island, the same detention occurred. When off Cornfield Point, (Saybrook,) witness told the engineer that the boat would not steer in the dark with such a heavy sea, and told him not to carry over seven inches, and repeated the same direction to the engineer when in the river. When crossing the bar at the mouth of Connecticut river, the boat steered very bad, and was obliged to ring the bell to shut off the steam. Missed the dock twice at Saybrook, in consequence of no person being on the dock to take a line. Backed down to near the Fort, where, owing to some difficulty with the valves, the boat could not be started ahead, and was obliged to anchor to prevent drifting on shore. Went into the engine-room and waited twenty minutes for the engineer to get ready for a start. Looked into the fire-room and asked if the water was plenty in the boilers, and was answered 'yes.' Got up the anchor and landed at Saybrook. Started again from Saybrook, and was obliged again to order the steam shut off, because it was difficult to steer the boat. Landed at Lyme, and on starting again, found that the boat jumped so with a head of steam, and steered so badly, that it was necessary to shut off the steam again, and continued shut off till we reached Essex, seven miles from Saybrook. Was detained three or four minutes in landing at Essex. When the small boat had landed, Capt. Waterman gave the word, and witness rung the bell to start the engine, and the explosion immediately followed.

The steam was not blown off at Essex. Witness thought at the time that there was too much steam on. Heard but one explosion, which was like a heavy fall or crash. Had been pilot of the New-England for 30 days, which was nearly as long as the boat had run.

The accident occurred an instant after ringing the bell to go ahead. Witness had felt apprehensions for his personal safety, on account of the pressure of steam which was carried; judged of this by the motion of the engine and the management of the boat. Saw at Saybrook the steam-gauge standing at 12 or 14 inches, and cautioned the fireman against carrying too much steam. The stop at Essex was no longer than 3 or 4 minutes.

The greatest distance gained of the Boston was about two miles and a half, which was near the head of the Sound. The Boston was nearly abreast when we entered the river. Witness is unable to make up his mind as to the cause of the accident, but thinks that the rent commenced in the legs of the boiler near the after end.

Giles Farnham, Fireman.—This witness was on duty at the larboard boiler. Took the first watch from New-York, and went below at 8 o'clock. Took his second watch after 12 o'clock, just before the boat entered the river. There were but 8 or 10 inches steam on the boiler before the boat arrived at Saybrook. The steam-gauge rose to 12 or 13 inches while lying at anchor at that place. Blew off the steam to 7 inches, and pumped water by hand into the larboard boiler. Witness says the water was lower in the boiler at this time than at any other, being at the 2d cock. The other boiler needed no supply. Witness examined the water every five minutes. Started from Saybrook with water at three cocks, and kept it afterwards at four cocks till the time of the accident. Above Lyme there was more steam on than there ought to be for the river. The floating stick in the steam-gauge in the larboard furnace was within two inches of the upper or boiler deck, when the boat stopped at Essex, and witness supposes it must have reached the deck previous to the accident.

While the boat was stopped at Essex, tried the water-cocks, and found the water as high as the upper cock. The witness then went over to the starboard fire-room, and told Bell, the other fireman on duty, that "he would not have to fire up again for a week if they went on so." Had but a moderate fire at this time in the furnace. Says the extra pressure was owing to the engine being shut off so much. At the moment of the explosion witness was sitting on the rail of the fire-room gangway, at the outside of the guard, conversing with Bell, the other fireman. Witness heard a sudden cracking of the boiler, and attempted to look round to see what was the matter, which was the last he knew till he found himself in the water. Was severely scalded, but succeeded in swimming to the shore. Witness says that when there was no steam on the boiler, the top of his gauge-rod was so short as to fall three inches below the top of the muzzle of the steam-gauge, and therefore did not indicate so much pressure as the gauge of the other boiler, that is, did not indicate the whole amount of pressure by three inches.

Edwin Bell, Fireman.—Was in charge of the starboard boiler at the time of the accident. Left New-York with seven inches steam, and carried about the same pressure till through Hurlgate, after which carried 12 or 13 inches till dark.

Was then directed by Mr. Younger to keep 8 or 9 inches, which was done till 8 o'clock, when witness took his watch below. Came on duty, and took the fire again at Saybrook, at which time there were 8 or 9 inches of steam on, and the fire was run down. Capt. Waterman came and asked witness about the water, examined and found three full cocks. Witness had no occasion to supply his boiler by the hand-pump. At Lyme, the steam-gauge was at 12 or 13 inches, and on reaching Essex, the gauge-rod was within 3 or 4 inches of the upper deck.

When the boat stopped it soon rose to the deck. Witness then turned off the condensed water from the steam-gauge, which caused it to fall about two inches, but it soon rose as high as before. Tried the water-cocks, and found good solid water at three lower cocks, and steam and water at the upper cock. Went over to the larboard boiler when first we stopped at Essex, and found 3 cocks of good water, and the gauge-rod three or four inches from the deck. The gauge-rod of the starboard boiler usually stood higher than the one in the larboard fire-room.

Witness never saw the float rods of the steam-gauges so high as at this time. Has run in the boat from her first trip. Witness told Giles (Farnham,) when the latter came into his room, "that they would not have to fire up more than once more during the whole watch."

There was a light fire kept up between Lyme and Essex. Witness heard no steam blown off at Essex. The accident happened about 3 o'clock in the morning. The New-England came out from New-York before the Boston. At 8 o'clock the Boston was about two miles astern.

Isaac Seymour, Mate.—Agrees in the statements made by Mr. Vail. In the Sound, from Sands' Point to Matinecock Point, the steam stood at the pressure of about 8 inches, and Mr. Marshall was some time blowing off. Marshall said that it was made faster than he wanted it, and he should speak to the fireman. Thinks there were 10 or 12 inches on the gauge in the engine-room, at the time when the boat was anchored at Saybrook, and they commenced blowing off. Saw the water tried in the boilers at Saybrook, which showed plenty. The larboard boiler was then pumped into by hand.

Perceived no difficulty in working the boat, except at Saybrook. Was not apprehensive of any accident. Was employed in landing with the small boat at Essex. Saw Mr. Marshall visit the fire-room just before the landing at Essex. Witness was facing the dock when he first heard a cracking noise, and was in the act of turning towards the steamboat when the explosion instantly followed.

The larboard boiler, which was nearest to witness, exploded a little before the other. Could just perceive the difference.

Roswell Potter, Engineer.—Witness has run the New-England as engineer since she first commenced running, except the first and last trip, when he stayed back on account of ill health. Had no reason to expect that any thing would go wrong. Usually carries from 14 to 17 inches of steam on the boilers of the New-England. The engine is intended for carrying 16 to 18 inches. Safety valve, as loaded at the time of the accident, would begin to blow off at 18 inches. Had three steam-gauges, which would rise from 31 to 32 inches without blowing out the mercury. Steam-gauges of this length are now used in the steam-boats. The gauges in the fire-rooms would stand 3¼ inches higher than the engineer's gauge in the engine-room; supposes this to be owing to the loss of heat from the steam in passing through the steam-pipe. Has run with Capt. Bunker to New-Haven, with steam at 8 inches. This was several years ago. Boilers are now made stronger than those which were formerly used.

The extreme of safe pressure on the boilers of the New-England he thinks to be 22 to 24 inches. The boat would not sail faster with this pressure than with 17 inches. Has had 24 inches on the boilers; once, when the boat was on trial, and at other times since. This was occasioned by stopping the engine. Has not seen the gauge rods rise as high as the boiler deck in any case. Witness examined the steam-gauge in the engine-room after the accident, and found it in perfect order, with the mercury remaining in the gauge. Also, found mercury in one of the fire-room gauges, both of which were torn down by the explosion. The height of the gauge rod, when up to the deck in the fire-room, would be 28 inches. After turning off the condensed water from above the mercury, we get the true guage. Has not known any racing with the New-England, except with the steamboat Providence, on which occasion had bad wood, and could get a pressure of but 11½ inches. The engineer must stand constantly at the engine to attend to the orders of the pilot. Was engineer of the steamboat Oliver Ellsworth for several years, and usually carried from 12 to 14 inches of steam on the boiler of that boat. The Oliver Ellsworth has the strongest boiler. The latter is made of stouter copper than those of the New-England, is 9½ feet in diameter by 16½ feet in length, and is stronger braced than any boiler the witness has ever seen. The engine of the New England is nearly four times the power of that of the Oliver Ellsworth. Thinks that the middle legs of the boilers were heated, and that they now appear to be annealed, and different from the outside of the boiler. The force pumps of the New England are very large, and will fill the boilers running over full from Saybrook to Essex. The New England will steer well with 8 or 10 inches steam in smooth water. The Oliver Ellsworth formerly carried from 12 to 14 inches, and now carries 16 to 18 inches. The M'Donough carries 12 to 14 inches. On being further examined, witness says that one of the boilers of the New-England was patched twice on the middle leg at the after end, and that a similar patch was put upon the same part of the other boiler. There was a crack in the flange at this point, which made it leak, but these repairs did not stop it. This was the trip previous to the accident. The safety valve would commence blowing off at 18 inches, but had carried 24 inches with the same weights, with the steam blowing through the valve. The boilers had not been proved above 24 inches. Had found the brace-bolts between the top of the furnace and the connection of the flues to the steam chimney to be leaky, owing to a straitening in the angle of the braces. Had taken them out, and put strait screw bolts in their stead. This was on the second trip which the boat made. Considers the engine to be of 120 horse power.

Adam Hall, Engineer.—Witness is chief engineer of the establishment of the West-Point Foundry Association. Made the engine and boilers of the New England. The boilers were 8 feet 4 inches wide, 8 feet high, and about 15 feet long. Each boiler had two arched flues and five circular return flues of 16 inches in diameter.

The arches were made of rolled copper, No. 3, wire gauge, the outer shell of No. 4, and the circular flues of No. 5. The boilers were placed one on each guard of the steamboat, at the distance of about 25 feet from the engine. The boilers were strongly braced with ⅞ inch bolts through the legs or flat sides, at the distance of 9 inches, and the arches were secured to the upper parts of the boiler by long bolts of ¾ inch copper, with screw fastenings. The steam-pipes were also of copper 10 or 10½ inches in diameter, and the safety valve was of the diameter of 10½ inches. The latter was calculated to blow off at a pressure of 20 inches; but the lever was afterwards shortened to about two feet, and new weights added, after the boat commenced running. There were four water cocks on each boiler, for ascertaining the height of the water.

The lowest of these cocks was three inches above the highest part of the upper flues, and each successive cock was placed three inches higher than the preceding one, the upper cock being twelve inches above the flues. Witness had proved the boilers. Thinks that the boilers should have borne fifty pounds to the square inch, if there had been no previous imperfection. The strength of copper, as compared with iron, is nearly as 3 to 5. The difference witness says is 60 per cent. in favor of iron. Copper has been preferred as a material for boilers, because it suffers less from corrosion. Copper is weakened by the action of heat at about 250 degrees. The strength of iron is increased when exposed to heat up to a certain point of temperature. A copper boiler will bear a greater pressure when cold than when

heated. An iron boiler, if not heated beyond 450, will bear a greater pressure than when cold. Has tried experiments with Mr. Stevens on a flat iron boiler, braced at distances of 8 inches, with ¾ inch brace bolts, at distances of 6 inches with ⅝ inch bolts, and at 5 inches with ½ inch bolts. One of the ¾ bolts broke at 756 pounds to the square inch; three of the ⅝ bolts gave way at 256 pounds to the inch, and ½ inch braces stood this pressure without injury. The power was applied by a water press, the safety valve being carefully loaded with an addition of 10 pounds at each trial. Witness thinks, from the appearance of the metal, that the rent of the boilers must have commenced in the arches near their connection with the after end. Knows Alexander Marshall, and would have no hesitation in trusting him with the care of an engine in any case. Witness employed him to take charge of a high pressure engine last winter.

Henry Waterman, Jr., Captain of the New-England.—Left New-York without working the engine warm, and run the steam down to 4 or 5 inches. The Boston left soon after us, and came up strong till we got through the gate. Then got on 10 or 12 inches of steam and drew away from the Boston. Might be 1½ or 2 miles ahead at 7½ to 8 o'clock. At this time felt a little alarmed for the laboring of the engine in the heavy sea with 12 or 15 inches. Usually works 14 or 18 inches when in full speed. Was often in the fire-room, till half past 10, when he retired. Below Falkner's Island, the wheelrope got foul, which brought him on deck, the boat boing in the trough of the sea. Crossed the bar, and got into the river at 1 o'clock, it being low water. Made two attempts to land at Saybrook, and failed, owing to there being no one to fasten a line on shore. Anchored in consequence of a difficulty in moving the valve rods, and blew off the steam. Observed the fireman pumping up one of the boilers, and ordered others to assist him. When the engineer was ready, got under way immediately, and went to the wharf. Heard no complaint of the boat behaving worse than common. Saw nothing unusual or alarming. Carried less steam in the sound than usual, on account of the heavy sea. Should have carried from 12 to 18 inches had the water been smooth. Had a favorable passage excepting the heavy sea. Did not notice the state of the steam after leaving Saybrook. Had no apprehension, or fears of any kind, at the time, and had heard none expressed by the passengers, or other persons on board. Had full confidence in the perfection and strength of the boilers and machinery. This confidence was derived from the experience we had already had. Witness has been five years in the steamboat business, and has had charge of a boat for the last 3 years. Was making no unusual exertions to reach Hartford early, and felt no inducement to such a course.

Has accidentally fallen in company with other steamboats since he has run the New-England, and had not been able to keep as much steam while so in company as was desirable, the boilers being too small for the engine, and could not, on an average, in these cases, keep more than 13 inches. Six persons were blown overboard by the explosion, of whom two were drowned. Witness is not able to form an opinion as to the immediate cause of the accident.

Mr. Samuel M. Hayden.—The witness lives at Essex, about 25 rods from the spot were the disaster occurred. Heard the steam when the New-England arrived at Essex, the noise of which continued while the boat was landing. Witness doubts if it was three minutes from the time he first heard the steam, till the explosion took place.

His first knowledge of the arrival of the steamboat was from hearing the steam. There were two distinct explosions, following very closely, and "lapping on to each other." The last explosion appeared to be the sharpest. Fifteen persons have died, including those whose bodies were found in the river.

Such is the evidence w ch was submitted to our consideration. It was also testified by one of the firemen, that the *damper*, by means of which the fire is held in check, was not closed during the stop at Essex, a fact which has not been recorded in its proper place. We consider it a remarkable fact, as well as an important circumstance in respect to the success of our investigation, that we have been able to obtain the testimony of the engineers and firemen who were on duty at the time of the explosion, all of whom were providentially saved. This has relieved the case from much of that obscurity which has rested on other disasters of this kind, where those immediately in charge of the boilers and engine have been the principal sufferers.

We annex sketches of the longitudinal and cross sections of the boilers of the New-England, reduced from the original drafts from which the boilers were constructed, which will serve to illustrate the foregoing descriptions.

The various theories and conjectures which have been put forward to account for this disaster may be comprized under the three following heads:

1. The production of some *gas*, (probably hydrogen,) suddenly evolved in great quantity

2. A supposed injurious *heating of the water legs*, (*d d d*, Fig. 2,) and lower parts of the boiler, in consequence of water being driven by the steam into the upper part of the boiler, and perhaps causing a rapid production of steam on its return to the heated metal.

3. A *deficiency*, at the time of the accident, *in the quantity of water* which it is necessary to carry in the boilers, owing to the carelessness of those in attendance, or to their being deceived in the examination of the water-cocks. It has been supposed that the metal of the boilers may thus have been weakened by heat, or that the sudden suffusion of water on the metal thus heated, occasioned by the sudden discharge of steam at the safety valve, may have generated steam in such quantity, and in

a manner so instantaneous, as to destroy the boiler.

4. *Stress of steam*, accumulated beyond what the boilers were able to sustain.

1. *It is suppposed by some that the explosion was produced by gas.*

2. *Others ascribe the explosion in question, to an over heating of the water legs of the boiler.*

3. *By others, the explosion is ascribed to deficiency of water.*

After some lengthy objections to these suppositions, which we have not room for, they state—

"We are constrained to adopt the remaining conclusion, and give it as the unanimous opinion of the board of examiners,—*That the explosion of the steamboat New England was caused by the pressure of steam, produced in the ordinary way, but accumulated to a degree of tension which the boilers were unable to sustain.*"

Fig. 1—Longitudinal Section.

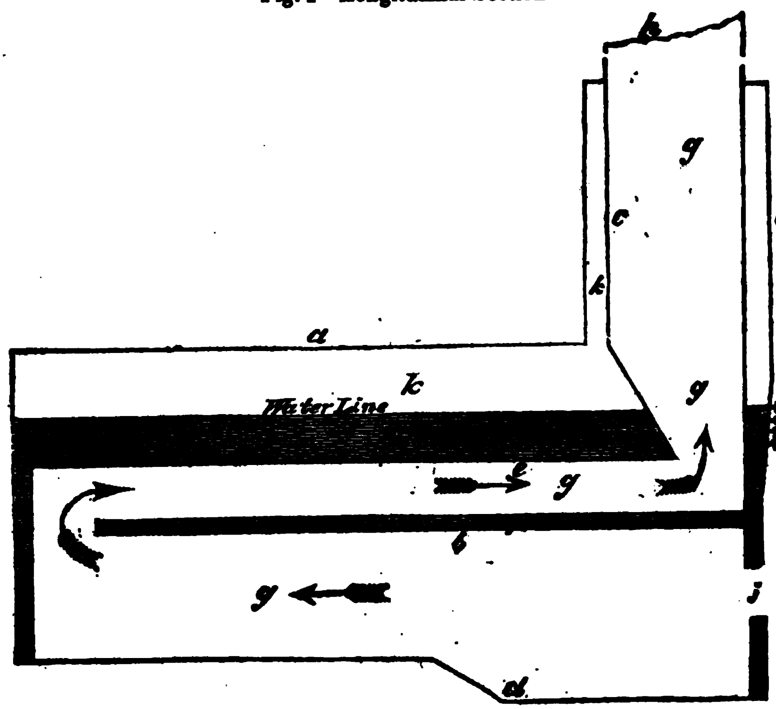
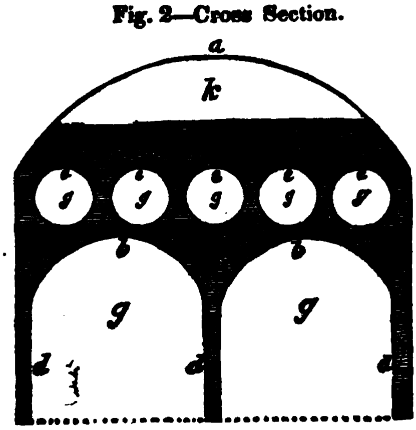


Fig. 2—Cross Section.



REFERENCES.—*a*, the outer shell of the boiler; *b b*, the arches or tops of the main or furnace flues; *c c*, the steam chimney; *d d d*, the water-legs; *e e e e e e*, the upper or return flues; *f f f*, the water in the boilers; *g g g g g*, the passage for the fire through the flues to the chimney; *h*, the iron chimney-pipe, cut off above its junction with the steam chimney; *j*, the furnace door; *k k*, the chamber; *i*, the water-cocks.

Centre of Gravity of a Ship.—A discovery, which is likely to be attended with important results to the navy, has recently been made by Commander John Pearce, R. N., of Plymouth. This officer, from various circumstances, was led to doubt that the *centre of gravity of a ship* was the *axis of rotation*, as hitherto imagined, and that this was the cause of so many errors occurring in masting. He accordingly proceeded to ascertain the truth of his doubts, by experiments on different models, which he has continued for upwards of twelve months, and the result, we understand, cannot fail to render the science of ship-building more comprehensive and demonstrative, as well as lead to the correction of other errors in the theory equally worthy of consideration! The axis of rotation has been fixed, by Capt. Pearce's experiment, at some distance above the gravity of the ship, and in the point which is known by the name of the lacentre; and we understand he considers the complexity of the theory, and not having considered the subject in a sufficiently practical shape, to have led authors into the error of confounding the centre of gravity of the ship with the axis of rotation; and that this has led to the error of supposing the lateral effort of the water, or resistance to leeway, to produce effects contrary to truth, and from which proceeds the present imperfect system of masting. In fact, the discovery of the true axis of rotation will be a complete key to the improvement of naval architecture, as *all the forces*, which are so constantly and variously acting, are estimated by the distances from the axis of rotation to the points where they are applied.—[London paper.]

The Rainbow.—The following reflections on this phenomenon are extracted from a work of considerable talent, Mr. Burke's "Beauties, Harmonies, and Sublimities of Nature." We have been favored with the author's corrections of the passage, as it is intended to appear in a third edition of his book, which is now preparing for the press.—[Penny Mag.]

The poets feigned the rainbow to be the residence of certain aerial creatures, whose delight it is to wanton in the clouds. Milton, in his exquisite pastoral drama, thus alludes to this Platonic idea:—

> I took it for a fairy vision
> Of some gay creature in the element,
> That in the colors of the rainbow live,
> And play i' th' plighted clouds.

The rainbow, which, not improbably, first suggested the idea of arches, though beautiful in all countries, is more particularly so in mountainous ones; for, independent of their frequency, it is impossible to conceive any arch more grand (if we except the double ring of Saturn) than when its extreme points rest upon the opposite sides of a wide valley, or on the peaked summits of precipitate mountains.

One of the glories which are said to surround the throne of heaven, is a rainbow like an emerald. In the apocalypse it is described as encircling the head of an angel; in Ezekiel, four cherubim are compared to a cloud, arched with it; and nothing, out of the Hebrew scriptures, can exceed the beauty of that passage in Milton, where he describes its creation and its first appearance.

There is a picture, representing this emblem of mercy, so admirably painted, in the castle of Ambras, in the circle of Austria, that the Grand Duke of Tuscany offered a hundred thousand crowns for it. Rubens frequently gave animation to pictures, which had little beside to interest the eye of the spectator, by painting this phenomenon: one of Guido's best pieces represents the Virgin and Infant sitting on a rainbow: and round the niche in which stood a statue of the Virgin in the chapel of Loretto, were imbedded precious stones of various lustres, forming a rainbow of various colors.

The rainbows of Greenland are frequently of a pale white, fringed with a brownish yellow; arising from the rays of the sun being reflected from a frozen cloud. In Iceland it is called the Bridge of the Gods; and the Scandinavians gave it for a guardian a being called Heimdaller. They supposed it to connect heaven with earth. Ulloa and Bouguer describe circular rainbows, which are frequently seen on the mountains, rising above Quito, in the kingdom of Peru; while Edward asserts, that a rainbow was seen near London, caused by the exhalations of that city, after the sun had set more than twenty minutes. A naval friend, too, informs me, that as he was one day watching the sun's effect upon the exhalations, near Juan Fernandez, he saw upwards of five and twenty *iris marinæ* animate the sea at the same time. In these marine-bows the concave sides were turned upwards; the drops of water rising from below, and not falling from above, as in the instances of aerial arches. They are sometimes formed, also, by waves dashing against the rocks: as may frequently be seen on the coast of Carnarvon, Marioneth, Pembroke, Cardigan, and Carmarthen.

In some rainbows may be discovered three arches within the purple of the common bow: 1. yellowish green, darker green, purple; 2. green, purple; 3. green, purple.

Rainbows, too, are sometimes seen when the hoar-frost is descending; and Captain Parry, in his attempts to reach the north pole by boats and sledges, saw a fog-bow, and no less than five arches formed within the main one, all beautifully colored.

Aristotle states that he was the first who ever saw a lunar rainbow: he saw only two in fifty years. He assuredly means he was the first who ever described one; since lunar rainbows must have been observed in all ages. That it was unknown to St. Ambrose, however, is evident, from his belief that the bow, which God promised Noah he would place in the firmament after the deluge, "as a witness that he would never drown the world again," was not to be understood of the rainbow, "which can never appear in the night; but some visible virtue of the Deity." Notwithstanding this assertion of St. Ambrose, I have had the good fortune to see several; two of which were, perhaps, as fine as were ever witnessed in any country. The first formed an arch over the vale of Usk. The moon hung over the blorenge; a dark cloud suspended over Myarth; the river murmured over beds of stones; and a bow, illumined by the moon, stretched from one side of the vale to the other.

The second I saw from the castle overlooking the bay of Carmarthen, forming a regular semi-circle over the Towy. It was in a moment of vicissitude; and fancy willingly reverted to that passage of Ecclesiasticus, where the writer describes Simon, shining "as the morning star," and "as a rainbow" on the temple of the Eternal. The sky soon cleared, and presented a midnight scene like that which Bloomfield has described so admirably:

"——above these wafted clouds are seen
(In a remoter sky, still more serene,)
Others, detached in ranges through the air,
Spotless as snow, and countless as they're fair;
Scatter'd immensely wide from east to west,
The beauteous semblance of a flock at rest,
These, to the raptur'd mind, aloud proclaim
Their mighty Shepherd's everlasting name."

Mill-Work.—Under this head we purpose noticing the simplest combinations of wheel-work which are employed in the construction of mills, and, under the articles Wind and Water Mills, complete views, both graphic and descriptive, will be given of their construction.

The business of a millwright is usually combined with the practical part of engineering, and much of the wind and water power formerly employed in giving motion to machinery is now superseded by the introduction of the steam engine. Indeed, without the agency of steam power, this country could in no shape compete with other manufacturing nations; so that, on account of the great importance of the steam engine as a prime mover, it will be advisable to devote a commensurate space to its illustration.

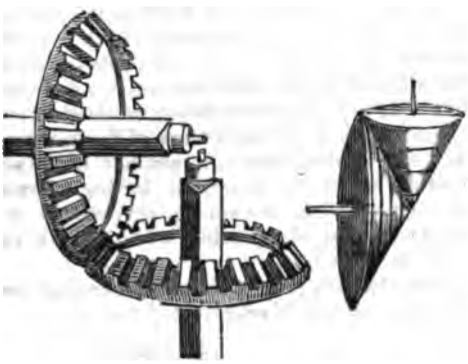
Various are the methods by which motion may be communicated from one part of a machine to another; and much of the skill of the millwright consists in his adapting certain methods to his particular purposes. Sometimes a simple cord, or a cord with pulleys, may be used. Levers, either simple or combined, are employed to communicate and also change the direction of the motion. Rods also are employed, which may be carried to a great distance by being connected together. But of all the modes of communicating motion, that by means of wheels is the most frequent. Wheels may be made to turn each other even by the simple contact of their surfaces when pressed together; or their circumferences may be formed into brushes with short thick hair, which enable them to turn each other with considerable force; or they may have cords, or straps of leather, or chains, passing from one to another; and at other times there are points or protuberances on the rims of the wheels. The most usual method, however, of making wheels drive each other, is by means of teeth. These are either cut into the substance of which the wheel is composed, when it is of metal; or formed at the same time as the rest of the wheel, when it is cast.

The proper method of shaping the teeth of wheels, so as to communicate the motion equally, and with as little friction as possible, is a matter of very great nicety, and has given rise to much study among mechanics. The ends of the teeth should be curves, but not parts of complete circles. They may be formed of the curve called the epicycloid, or of the involutes of circles, which are curves described by a point of a thread, which has been wound round the wheel while it is uncoiled.

A wheel which has teeth cut upon the circumferences, so as to project out in the plane of its face, is called a spur wheel; and, when the projection of the teeth is at right angles to the face of the wheel, and parallel to the axis, the wheel is called a crown or contrate wheel. Sometimes the faces of the two wheels are in the same plane, and consequently the axes parallel; and at other times the axes are at right angles to each other, one being a spur and the other a contrate wheel.

There is a mode of placing the teeth frequently resorted to, which consists in level-

ling the edge of the wheel, and cutting the teeth on the bevel, by which they may turn in each other, though variously inclined, and the teeth have also great strength. The principle consists in the cones rolling on the surface of each other, as in the annexed right-hand engraving; if their bases are equal, they will perform their revolutions in one and the same time.

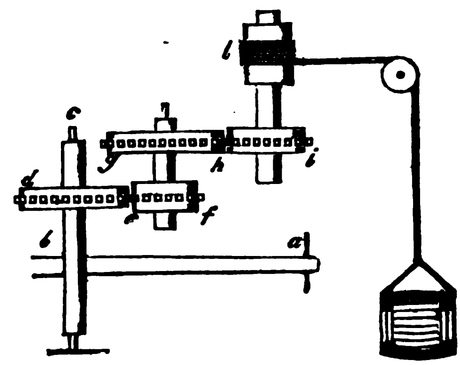


If the cones are fluted, or have teeth cut in them diverging from the centre, they are then called *bevel geer*. The teeth may be made of any dimension, according to the strength required; and it is of great use to communicate a motion in any direction, or to any part of a building. The bevel geer represented in the left-hand figure must be supported by a frame at the point where the pivots intersect each other. The frame is usually formed of iron or wood, and when the latter is employed the pivot-hole is of brass. The perpendicular shaft should always be made to revolve on a sharp point in the centre.

Hook's universal joint, (described at page 154, vol. ii,) may be applied to communicate motion instead of bevel geer, where the speed is to be continued the same, and where the angle does not exceed thirty or forty degrees and the equality of motion is not regarded; for, as it recedes from a right line, its motion becomes very irregular. This joint may be constructed by a cross, or with four pins fastened at right angles upon the circumference of a hoop, or solid ball. It is of great use in cotton mills, where the tumbling shafts are continued to a distance from the moving power.

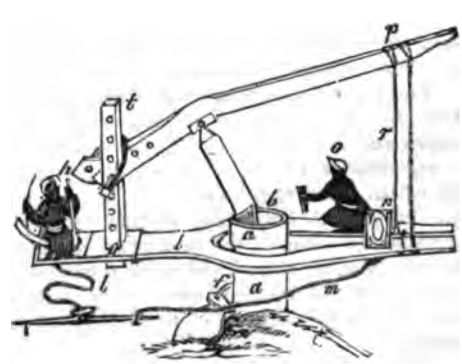
The employment of animal power in the simplest species of mill-work may be well illustrated by the accompanying sketch, in which a horse may be attached to a long lever, and thus made to raise a weight by a train of wheels and pinions.

The weight to be raised is suspended by a rope or chain which winds round the drum, *l*. On the same axis is placed a wheel, *i*, actu-



ated by another wheel, *g h*. The wheel, *d e*, gives motion to the whole, by the intervention of the small wheel at *f*. A horse at *a* may be considered as the prime mover, as the lever *a b* is on the axis *c*. Now, in this apparatus, there is a loss of power, but a gain in velocity.

The various modes of constructing mills for domestic, as well as manufacturing processes, will be explained hereafter, and we now purpose confining ourselves to a single example of the mode of employing animal power, in a way which, from its simplicity, might be adopted to a great extent in this country. There is a mill of a cheap and effective kind used in many parts of the East, which appears to have suggested the use of the ordinary snuff-mill. Indeed, it is, in some respects, superior to it. This mill, which is employed in the preparation of sugar, consists of a mortar, beam, lever, pestle, and regulator, as represented in the engraving beneath:



The mortar, *a a*, is a tree about ten feet long and fourteen inches over, which is sunk in the earth, so as to leave about two feet above ground. At the top is formed a conical cavity like a funnel, which ends in a hollow cylinder, with a hemispherical projection at the bottom, in order to allow the juice to run freely to the small opening that

conveys it to a spout, *f*, from which it runs into an earthen pot. Round the upper mouth of the mortar is a circular cavity, *b*, which serves to collect any of the juice that may run over from the upper end of the pieces of cane. A channel is cut to convey this juice down the outside of the mortar to the spout, *f*.

The beam, *i*, is about 16 feet long and 6 inches thick, and is cut from any large tree that is divided by a fork into two arms. A hollow circle is made in the fork for the mortar, round which the beam turns horizontally: the surface of this excavation is secured by a semi-circle of some strong wood; the other end of the fork is left quite open, in order that the beam may be changed without any trouble. The bullock driver sits on the undivided end, to which the cattle are yoked by a rope, *l*, from his end of the beam, and they are kept in the circular tread by another rope, *m*, which passes from the yoke to the forked end of the beam. A basket, *n*, is placed upon the forks to hold the cuttings of the cane, and the man, *o*, who feeds the mill, sits between this basket and the mortar. He takes care to place the pieces of cane sloping down the cavity of the mortar, just at the time that the pestle comes round; and after the pestle has passed, he removes those which have been squeezed.

The lever, *p*, is a piece of timber nearly as long as the beam. The thickest end, which is also the lowest, is connected with the undivided end of the beam by means of a regulator, *t*. A little way from the place where it is joined to the regulator, a piece of very hard wood is morticed into the lower side of the lever, and a smooth conical hollow is made in this piece, to receive the head of the pestle. The end of the lever furthest from the regulator is fastened by two ropes to the two arms of the beam.

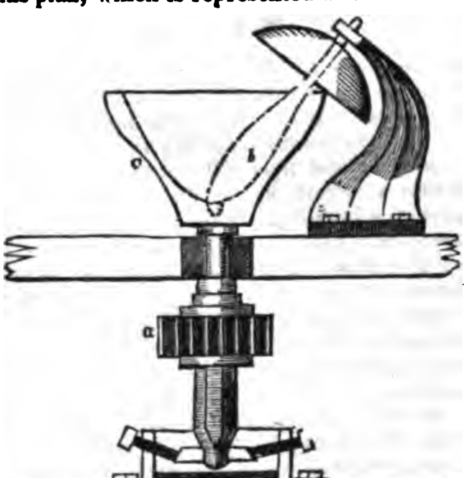
The pestle is a strong cylindrical piece of timber, cut to a point at each end. The upper end is a smooth cone, the lower end a pyramid of 12 to 15 sides, at the point of which is a strong cylinder. As the pestle is placed obliquely, it rubs strongly against the sides of the mortar as it passes round; and its cylindrical point rubs also on the top of the hemispherical projection, *d*, which is in the bottom of the cavity of the mortar.

The regulator, *t*, is a strong square of timber, which passes through the undivided end of the beam, and is secured below it by part of its circumference being left for cheeks. It is pierced by eight holes, and a pin is placed in the lowest hole, to prevent the regulator from falling when the strain is removed.

The canes with which the mill is supplied are cut into pieces six inches long. The mill goes night and day during crop time, and presses about fifty-six pots, or 218 gallons of juice, in that time. Two bullocks are used at a time, and as they are driven very fast, they are changed every time three pots of juice are expressed, and work no more that day.

In the manufacture of snuff in this country, the grinding is performed by a loaded pestle, made to turn round as it rubs against the sides of a cast iron mortar, the pointed lower end of the pestle being retained in its place by a hole at the bottom of the mortar. In large manufactories, a number of these mortars are placed in a circle, having a large toothed wheel in the centre, surrounded by as many upright spindles, with pinions to work in the wheel.

Mr. Gill has proposed an improvement on this plan, which is represented beneath:



The mortar, *c*, is in this arrangement made to revolve, and the pestle, *b*, is supported by a bracket firmly attached to the beam beneath. The pinion, *a*, rests on a conical axis, and communicates, as in the old arrangement, with the principal driving wheel.

Water-mills are of three kinds: *Breast-mills*, *undershot-mills*, and *overshot-mills*, according to the manner in which the water is applied to the great wheel. In the first, the water falls down upon the wheel at right angles to the *float-boards*, or bucket, placed to receive it. In the second, which is used where there is no fall of water, the stream strikes the float-boards at the lower part of the wheel. In the third, the water is poured over the top, and is received in buckets arranged round the wheel.

A less quantity of water will turn an overshot mill (in which the wheel has buckets instead of float-boards) than a breast-mill, where the fall of water seldom exceeds half the height of the wheel; so that, when there is but a small quantity of water, and a fall great enough for the wheel to lie under it, the bucket, or overshot-wheel, is always used; but, where there is a large body of water, with a small fall, the breast or float-board must be used. Where the water runs only upon a small declivity, it can act but slowly upon the under part of the wheel, in which case the motion of the wheel will be slow; and therefore the floats ought to be very long, that a large surface of water may act upon them, so that what is wanting in velocity may be made up in power; and then the cog-wheel may have a greater number of cogs in proportion to the rounds in the trundle, in order to give the mill-stone a sufficient degree of velocity.

It was the opinion of Smeaton, that the powers necessary to produce the same effect on an undershot-wheel, a breast-wheel, and an overshot-wheel, must be to each other as the numbers 2·4, 1·75, and 1.

Wind, which we may consider as the next substitute for animal power, appears to have been first employed to give motion to machinery in the beginning of the 6th century. The use of this species of mechanical force is, however, principally limited to the grinding of corn, the pressing of seed, and other simple manipulations, the great irregularity of this element precluding its application to those processes which require a continued motion.

A windmill with four sails, measuring seventy feet from the extremity of one sail to that of the opposite one, each being six feet and a half in width, is capable of raising 926 lbs. 232 feet in a minute, and of working on an average eight hours per day. This is equivalent to the work of 34 men, 25 square feet of canvass performing the average work of a day laborer. A mill of this magnitude seldom requires the attention of more than two men; and it will thus be seen that, making allowance for its irregularity, wind possesses a decided superiority over every species of animal labor.

The following very important errors have frequently been made by mathematicians and practical mechanics, in the estimation of the force of the wind or the water on oblique surfaces; they have generally arisen from inattention to the distinction between pressure and mechanical power. It may be demonstrated that the greatest possible pressure of the wind or water, on a given oblique surface at rest, tending to turn it in a direction perpendicular to that of the wind, is obtained when the surface forms an angle of about 55° with the wind; but that the mechanical power of such a pressure, which is to be estimated from a combination of its intensity with the velocity of the surface, may be increased without limit by increasing the angle of inclination, and consequently the velocity. The utmost effect that could be thus obtained would be equal to that of the same wind or stream acting on the float-boards of an undershot-wheel; but, since in all practical cases the velocity is limited, the effect will be somewhat smaller than this: for example, if the mere velocity of the sails or float-boards be supposed equal to that of the wind, the mechanical power will be more than four-fifths as great as that of an undershot wheel; that is, in the case of a windmill, more than four-fifths of the utmost effect that can be obtained from the wind. In such a case Maclaurin has shown that the sails ought to make an angle of 74° with the direction of the wind: but in practice it is found most advantageous to make the angle somewhat greater than this, the velocity of the extremities of the sails being usually, according to Mr. Smeaton, more than twice as great as that of the wind. It appears, therefore, that the oblique sails of the common windmill are in their nature almost as well calculated to make the best use of any hydraulic force as an undershot-wheel; and, since they act without intermission throughout their whole revolution, they have a decided advantage over such machines as require the sails or fans to be exposed to a more limited stream of the wind during one half only of their motion, which is necessary in the horizontal windmill, where a screen is employed for covering them while they are moving in a direction contrary to that of the wind: and such machines, according to Smeaton, are found to perform little more than one-tenth of the work of those which are more usually employed. The sails of a common windmill are frequently made to change their situation, according to the direction of the wind, by means of a small wheel with sails of the same kind, which turns round whenever the wind strikes on either side of it, and drives a pinion turning the whole machinery; the sails are sometimes made to furl or unfurl themselves, according to the velocity of the wind, by means of a revolving pendulum, which rises to a greater or less height, in order to prevent the injury which the flour would suffer from too great a rapidity in the motion, or any other accidents which might

happen in a mill of a different nature. The inclination of the axis of a windmill to the horizon is principally intended to allow room for the action of the wind at the lower part, where it would be weakened if the sails came too nearly in contact with the building, as they must do if they were perfectly upright. When it is necessary to stop the motion of a windmill, a break is applied to the surface of a large wheel, so that its friction operates with a considerable mechanical advantage.—[Partington's Scientific Gazette.]

Singularity of Records.—There is, perhaps, no one principle in human nature that leads to greater consequences, than the concentration of application to singular research.

But this, like every other principle, has occasionally strange and useless terminations, that may be called *lusus naturæ* in mortals. As an instance of this, I will present you with the result of a man's labor for three years, eight or nine hours in a day, Sundays not excepted, to determine the verses, words, and letters, contained in the Bible.

Verses	31,173
Words	773,692
Letters	3,566,480

The middle and the least chapter is the 117th Psalm.

The middle verse is the 8th verse of the 171st Psalm.

Jehovah is named 6,855 times. The middle of these Jehovahs is in second Chronicles, fourth chapter and 16th verse.

The word *and* is found in the Bible 46,227 times.

The least verse in the Old Testament, is in first Chronicles, 1st and 10th verses. The least in the New Testament, 11th chapter of John, 35th verse.—[London paper.]

Genius in Prison.—It was in prison that Bœthius composed his excellent work on the 'Consolations of Philosophy;' it was in prison that Goldsmith wrote his 'Vicar of Wakefield;' it was in prison that Cervantes wrote 'Don Quixote,' which laughed knight errantry out of Europe; it was in prison that Charles I. composed that excellent work, the 'Portraiture of a Christian King;' it was in prison that Grotius wrote his 'Commentary on St. Matthew;' it was in prison that Buchanan composed his excellent 'Paraphrase on the Psalms of David;' it was in prison that Daniel Defoe wrote his 'Robinson Crusoe,' (he offered it to a bookseller for ten pounds, which that liberal encourager of literature declined giving;) it was in prison that Sir Walter Raleigh wrote his 'History of the World;' it was in prison that Voltaire sketched the plan and composed most of the poem of 'The Henriade;' it was in prison that Howler wrote most of his 'Familiar Letters;' it was in prison that Elizabeth, of England, and her victim Mary, Queen of Scots, wrote their best poems; it was in prison that Margaret of France (wife of Henry IV.) wrote 'An Apology for the Irregularity of her Conduct;' it was in prison that Sir John Pettas wrote the book on metals, called 'Fleta Minor;' it was in prison that Tasso wrote some of his most affecting poems. With the *fear* of a prison, how many works have been written!—[Ladies' Magazine.]

(The list may be extended. Pelico's Memoirs are a recent example.)

Automaton Juggler.—The Paris Journal des Debats gives us an account of a curious piece of mechanism invented by a watchmaker at Haute Ville. On an ornamented case, a juggler, about six inches in height, and dressed in Turkish costume, is represented seated beneath a canopy, with a little table before him; at his right is a stand, on which are placed three goblets and a drum. In the first place you hear a delightful overture executed by some internal mechanism; when this is finished, the little juggler, as a juggler should, rises and bows three times to the company: he then takes two of the goblets, and three silver balls, which he causes to pass successively from beneath one of the inverted goblets to the other, so rapidly as to deceive the eye, until they are all found at last under one. He then replaces the goblets, and strikes three times upon the drum, which opens and displays a little dancer, who flourishes upon the table with infinite grace, accompanied by music produced by mechanism, while the juggler beats the time, and expresses his approbation by significant gestures. The dancer then retires within the drum, and the juggler lifts the third goblet, beneath which is perceived a silver egg, from which issues a beautiful and richly colored little bird. This bird takes its station on the egg, claps its wings, and sings an air; when this is over, the juggler replaces the goblet, bows, and resumes his seat, and another air closes the exhibition. The artist was employed for the space of five years in completing this piece of mechanism, and sold it for 300,000 francs.

Utility the only Test of Merit.—Antiquity is worthless, except as the parent of experience; that which is useful is alone venerable; that which is virtuous is alone noble, and there is nothing so illustrious as the de-

dication of the intellect and the affections to the great end of human improvement and happiness: an end which will be the ultimate test and touchstone of all our institutions, by a reference to which they will be judged, and either perpetuated or swept away.—[Westminster Review.]

Advice on the Care and Management of Tools.—From a new edition of the Cabinet Maker's Guide, we quote the following:

"The goodness of saws, chisels, and other edge tools, depends upon the quality of the steel, which should be uniform throughout, and it is always better to have them tempered too hard than too soft, for use will reduce the temper. If at any time you wish to restore the temper, and to perform the operation yourself, the best method is to melt a sufficient quantity of lead to immerse the cutting part of the tool. Having previously brightened its surface, then plunge it into the melted lead for a few minutes, till it gets sufficiently hot to melt a candle, with which rub its surface; then plunge it in again and keep it there until the steel assumes a straw color, (but be careful not to let it turn blue,) when that is the case take it out, rub it again with the tallow, and let it cool; if it should be too soft, wipe the grease off and repeat the process without the tallow, and when sufficiently hot, plunge it into cold spring water or water and vinegar mixed.

"By a proper attention to these directions, and a little practice, every workman will have it in his power to give a proper temper to the tools he may use.

"If a saw is too hard, it may be tempered by the same means; if you are near a plumber's shop, you may repeat the process conveniently and without expense, when they are melting a pot of lead.

"In other cutting tools you must wait till the steel just begins to turn blue, which is a temper that will give it more elasticity, and at the same time sufficient hardness."

The Persecutions of Genius.—The successful efforts of genius have not been more remarkable in the biography of eminent individuals, than the miseries which have often, during barbarous times, been endured by men of learning and scientific skill, through the ignorance of the very persons whom they intended to benefit. It is only, indeed, in the present age that we find the discoverers of new arts and sciences rewarded with the approbation of their fellows, if not with more substantial gifts; and in considering what has from first to last been the amount of the cruel persecutions of the learned, the existing generation can hardly believe it credible that so much wanton abuse of power can have been exercised. On this subject of melancholy interest, D'Israeli, in his Curiosities of Literature, has collected a variety of striking particulars. "Before the times of Galileo and Harvey (says this accurate writer), the world believed in the diurnal immoveability of the earth, and the stagnation of the blood; and for denying these, the one was persecuted, and the other ridiculed. The intelligence and virtue of Socrates were punished with death. Anaxagoras, when he attempted to propagate a just notion of the Supreme Being, was dragged to prison. Aristotle, after a long series of persecutions, swallowed poison. The great geometricians and chemists, as Gerbert, Roger Bacon, and others, were abhorred as magicians. Virgilius, Bishop of Saltzburg, having asserted that there existed antipodes, the Archbishop of Mentz declared him a heretic, and consigned him to the flames; and the Abbot Trithemius, who was fond of improving stenography, or the art of secret writing, having published some curious works on that subject, they were condemned as works full of diabolical mysteries. Galileo was condemned at Rome publicly to disavow his sentiments regarding the motion of the earth, the truth of which must have been abundantly manifest: he was imprisoned in the Inquisition, and visited by Milton, who tells he was then *poor* and *old*. Cornelius Agrippa, a native of Cologne, and distinguished by turns as a soldier, philosopher, physician, chemist, lawyer, and writer, was believed to be a magician, and to be accompanied by a familiar spirit in the shape of a black dog. He was so violently persecuted that he was obliged to fly from place to place; the people beheld him as an object of horror, and not unfrequently, when he walked, he found the streets empty at his approach: this ingenious man died in an hospital. When Urban Grandier, another victim of the age, was led to the stake, a large fly settled on his head: a monk, who had heard that Beelzebub signifies in Hebrew the God of Flies, reported that he saw this spirit come to take possession of him.

Even the learned themselves, who have not applied to natural philosophy, seem to have acted with the same feelings as the most ignorant; for when Albertus Magnus—an eminent philosopher, of the thirteenth century—constructed an automaton, or curious piece of mechanism, which sent forth distinct vocal sounds, Thomas Aquinas (a celebrated theologian) imagined it to be the devil, and struck it with his staff, which, to the mortification of the great Albert, annihilated the labor of thirty years. Descartes was horribly persecuted in Holland when he first published his opinions: Voetius, a person of influence, accused him of Atheism, and had even projected in his mind to have this philosopher burnt at Utrecht in an extraordinary fire, which, kindled on an eminence, might be observed by the seven provinces. This persecution of science and genius lasted till the close of the seventeenth century."

Locomotive Engines on Common Roads. Mr. Byington, an ingenious mechanic of Pitts-

burg, is engaged in the construction of a locomotive steam engine, on an improved plan, and intended to be used on common or turnpike roads. The Pittsburg Statesman says, Mr. B. is confident that he has discovered an improvement by which a locomotive engine may be made to operate on such roads with perfect success. Let us hope that this confidence on the part of the builder is not premature or ill founded. If experience shall justify it, and he succeed in his undertaking, he will prove himself one of the benefactors of the age.—[Baltimore Patriot.]

Smoky Chimneys.—Among the many sufferings arising from the limited diffusion of science, that from smoky fireplaces is by no means the least. Independent of the direct inconvenience of smoke in the room, dangerous colds are often taken from hoisted windows or opened doors. What a beautiful picture of comfort is presented on entering, in cold December day, an apartment, the inmates of which have red and tearful eyes, and stand or sit shivering in currents of cold air! Count Rumford observes that the general fault of common chimneys is the greatness of the opening at the throat. The following is a condensed view of some of his rules:

"1. The *throat* of the chimney should be perpendicularly over *the fire*, as the smoke and hot vapor which rise from a fire naturally tend *upwards*. By the *throat* of a chimney is meant the lower extremity of its canal, where it unites with the upper part of its open fireplace. 2. The nearer the throat of a chimney is to the fire the stronger will be its *draught*, and the less danger of its smoking; since smoke rises in consequence of its rarefaction by heat, and the heat is greater nearer the fire than at a greater distance from it. But the draught of a chimney may be too strong, so as to consume the fuel too rapidly; and, therefore, a due medium must be fixed upon, according to circumstances. 3. That *four inches* is the proper width to be given to the throat, reckoning across from the top of the breast of the chimney, or the inside of the mantle, to the back of the chimney; and even in large halls, where great fires are kept up, this width should never be increased beyond 4½ or 5 inches. 4. The width given to the back of the chimney should be about *one-third* of the width of the opening of the fireplace in front. In a room of middling size, *thirteen inches* is a good size for the width of the back, and 3 times 13 or 39 inches for the width of the opening of the fireplace in front. 5. The angle made by the back of the fireplace and the sides of it, or covings, should be 135°, which is the best position they can have for throwing heat into the room. 6. The back of the chimney should always be built *perfectly upright*. 7. Where the throat of the chimney has an end, that is to say, where it enters into the lower part of the open canal of the chimney, *there* the three walls which form the two covings and the back of the fireplace should *all end abruptly*, without any slope, which will render it more difficult for any wind from above to force its way through the narrow passage of the throat of the chimney. The back and covings should rise 5 or 6 inches higher than the breast of the chimney. 8. The current of air, which, passing under the mantle, gets into the chimney, should be made *gradually to bend its way upwards*; by which means it will unite *quietly* with the ascending current of smoke. This is effected with the greatest ease and certainty, merely by *rounding off* the breast of the chimney, or back part of the mantle, instead of leaving it flat or full of holes and corners. Fig. 1 shows the section of a chimney on the common construction, in which *d e* is the throat. Fig. 2 shows a section of the same chimney altered and improved, in which *d i* is the reduced throat, four inches in the direction *d i*, and thirteen inches in a line parallel to the mantle."

Fig. 1.

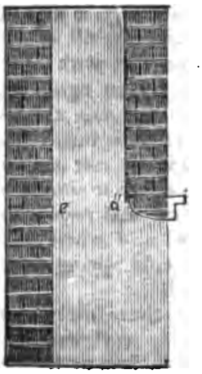
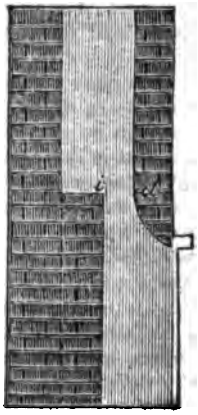


Fig. 2.



Statistics of the Globe.—The rapid population of the globe is estimated variously from 600,000,000 to 800,000,000; the geographical square miles at nearly 38,000,000, or 49,000,000 English square miles. The population to a square mile is, in France 61, Asia 27, Africa 19, America 3, Oceanica less than 1; the average of all about 17. The densest population in any whole province or state, is in Hamburg, where it is 1302 to a square mile. It is 980 in Bremen, 783 in Frankfort, 523 in Lubec, 464 in Lucca (Italy), 392 in Belgium, 314 in Saxony, 277 in Holland, 257 in Great Britain, the Sicilies 236, 208 in France, Austria 165, Prussia 155, Portugal 121, Denmark 119, Spain 101, Turkey 63, Greece 51, Russia 37.

In Asia some provinces have a population of from 200 to 500 to the square mile; Japan 139, China 42, Siam 57, English Indian Empire 185. In Africa, Morocco has 46, Tunis 45, and some of the interior kingdoms a little more. In America, Hayti has 36, Central America 12, Chili 10, United States 7½, Mexico 6.—[N. E. Farmer.]

Internal Improvements, No. III. By F. To the Editor of the American Railroad Journal, and Advocate of Internal Improvements.

Sir—The faculties of the human race may remain for generations in a state of torpor, but when once roused into action, they cannot easily be lulled again into inactivity and repose. Thus all innovations on old established customs, however plausible in appearance, are ever treated with distrust, and only admitted to confidence after a long series of successful experiments may have demonstrated the truth of the principles advanced. Then, as the eyes of men gradually open, and the cloud which had obscured their understandings is dispersed, they begin to marvel at the obtuseness of their own perceptions in not sooner comprehending the nature of the advantages predicted. How far this will be exemplified in the introduction of steam carriages on common roads, as a substitute for horse power, in the transport of goods and passengers, remains yet to be proved. Sceptics have not been wanting, to vociferate their timidity against its preferment, and pronounce its visionary character; and yet, the time may not be distant when the project will be hailed by the whole British nation as a confirmed blessing, and another step in the grand march of practical science. She may, ere long, be destined to witness her highways and byways, like her railroads and rivers, traversed from one end of the kingdom to the other, under the all-pervading influence of steam.

Experiments have already been made on a large scale, and with sufficient success to demonstrate to the minds of all those who feel an interest in the subject, the practicability, as well as capability, of the project, to realize all the hopes and expectations with which it has been endowed by its projectors. That it is destined, at no very remote period, to mark a new and important era in the means of intercourse among our transatlantic brethren, it would be folly to entertain a doubt; but, at the same time, we do not hesitate to say, that however applicable it may be to their present condition, the time is not yet arrived when its adoption as a matter of expediency can be recommended to this country. Our situation, in this respect, is in no way analogous to that of Great Britain. What would act as a benefit and blessing to her, would, in this case, prove a positive evil to us. But, before attempting to maintain this position, it will be necessary to state the principal objections already advanced against its introduction. They are as follows:—The insecurity of carriages so propelled; the liability of boilers to explosion; the annoyance of travellers by noise of machinery, and the escape of smoke and waste steam. These objections were in part answered before the House of Commons, during the examinations there held to collect information on this subject. It was then stated that the construction of the boilers was such that the steam could only act in very small quantities on any one part, and that even in the event of explosion, the danger would be comparatively trifling, and seldom or never attended by loss of life; that the escape of smoke might be prevented by the use of coke; and that the waste steam might be made to pass into the fire to increase the draft. It was further stated, that carriages properly constructed were capable of attaining a velocity of from ten to thirty-five miles per hour, on a level; that an acclivity of one in six had been surmounted at the rate of sixteen and a half miles per hour; and that a practical velocity of from twelve to fourteen miles per hour, where the minimum breadth of the wheel tire was three and a half inches, might be sustained without injury either to carriage or road.

How far these positions will hold in practice we are not at present prepared to say. But whatever may be the result in England, we need not hesitate to repeat the assertion that the period is very remote when the adoption of steam carriages will be deemed justifiable on the roads of America. It must be remembered that England is burthened with a large surplus population, and that every tax on agricultural produce, as a consequence, is accompanied by a proportionate degree of distress. Every suggestion, therefore, in the way of relief, commands immediate attention, and receives encouragement and support according as its merits may seem to justify. In Great Britain, there are more than a million of horses engaged in various ways in the transportation of goods and passengers; and it is estimated that it requires as much land for each horse as would on an average support eight men; or, in other words, the adoption of this new project would increase the capacity of the country to maintain eight millions of souls over and above what it is at present burthened with. Now, under these circumstances, it cannot be denied that the subject is deserving the attention of all philanthropists, not only as having a tendency to alleviate the distress of a large and meritorious portion of the population, but also as obviating the existing necessity for the abuse of that noble spirited animal, the horse. But these arguments cannot obtain in a country like our own, where the whole amount of population is small in comparison of the extent of territory; where large tracts of fertile land yet remain untilled, and extensive forests unlopped, by reason of the paucity of agriculturists. These blanks must be filled up before our harvests can possibly prove unequal to the demand made against them; and then it becomes a question of economy as combined with general convenience to all classes of persons interested.

As to economy, it is roundly asserted by our brethren on the other side of the water, that steam coaches can be run for from one-third to one-fifth the cost of post-coaches. This may be true enough—indeed it is believed to be so, from the fact that an ordinary coach, weighing two tons, can carry but eighteen persons, while a steam coach of the same weight may be made to carry double that number, and that the action of the wheels, where the tire is six inches wide, has a tendency rather to consolidate than cut up the road.

But another consideration of more importance to us claims attention, in the price of coke, which must necessarily enter largely in the expense of running all engines of whatever description, where steam is to be rapidly generated. It is a well established fact, that the price of this article is much greater in this country than in any other; so much so, that it becomes a question whether its use would not thereby be altogether unavailable. Should this prove to be the case, then other means must be resorted to for the destruction of the sublimated and volatilized matter always attendant on the combustion of coals in their natural state. This not admitting of any chemical combination, must be effected in some way by mechanical means. Before the House of Commons, it was stated that the effect might be produced by causing the smoke to pass through sand mixed with quicklime, by which the carbonic acid being absorbed, the carbonic oxyde and hydrogen was left in such a free state as to be combustible. This process, however, is altogether too slow in its operation to admit its practical application for any purposes of locomotion; and it is therefore only deserving of notice as an incitement to further discoveries.

But it may be asked, and with some show of reason, where are our extensive mines of anthracites? This species of coal is of such a nature as at once to do away with every objection that has been advanced against the use of other descriptions; for, not producing smoke of any kind, it may be used with impunity, without having recourse to artificial preparations. This would seem to be true enough, and to a certain extent is so—that is to say, the use of anthracite coals would most assuredly remedy the evil to which the public would be exposed from the escape of smoke, where bituminous coals were used in the generation of steam to propel carriages; but the difficulty unfortunately rests in the fact that steam cannot be generated with sufficient rapidity for this purpose, without the action of flame upon the boiler; and the combustion of this coal not producing any flame, recourse must be had to some extrinsic means for the attainment of that end. This end, it is true, has been particularly attained by experiment in the decomposition of water, by passing a jet, under the action of the engine, constantly over the bed of hot coals. But this experiment, though it may eventually be made to answer the purpose, does not as yet seem to have been sufficienly tested in practice to render it available in ordinary cases; and as we do not wish to indulge in speculations of any kind, we shall forbear to express an opinion on the subject until the results of more extended trials may be made known.

It requires, however, no great stretch of human foresight to predict that the introduction of steam carriages on common roads will be a signal to the abandonment of all ordinary modes of travelling. They must be exclusively adopted or not at all, and therefore it will be necessary for all persons, desirous of moving from place to place, to be dependent entirely on the public conveyances for its accomplishment. Now, it is a well known fact, that all farmers who inhabit mountainous districts, or such as are yet unpenetrated by either railroad or canal, must of necessity be their own carriers. The expense of maintaining one, two, or more horses, is comparatively trifling. They are absolutely necessary to the prosecution of their agricultural pursuits, and after their harvests are gathered in, they are equally useful in the transportation of the proceeds to market.

These observations naturally suggest themselves as objections to the introduction of this new mode of conveyance among us for a long time to come; and they are introduced here simply because we think that we have discovered a growing disposition among some of our speculators to embark in the project. Our necessities alone should dictate the period when this revolution ought to take place; and even then, where so many changes are to be made, so many prejudices to be overcome, and so many jarring interests to be reconciled, all the influence of legislative support will be requisite to establish it on a firm foundation.

This period, however, it is believed, has already arrived in England. She feels herself bending under a burthen which, unless soon lightened, will eventually bear her down. She feels the necessity of adopting some decided measures for the relief of the lower orders of society. With these feelings generally prevalent, it is not to be surprized at that her mechanics should take advantage of the first opportunity that offered a fair prospect of success, to start a fresh track, and open a new avenue to the resources of the country. The facilities afforded by the genius of McAdam pointed out the way; the hard and uniform surface of his roads suggested the practicability of the undertaking; and although we sincerely deprecate its immediate adoption here, we earnestly wish it all the success, in the land of its birth, that its undoubted merits have a right to claim. F.

New-York, 8th Dec., 1833.

Undulating Railway.—A series of experiments have been some time in progress, on a part of the Liverpool and Manchester railway, for the purpose of ascertaining the practicability of a scheme suggested and very strongly entertained by Mr. Badnall, of impelling carriages upon a railway by means of a power derived from the inequalities or undulations of the line. The directors of the railway liberally allowed Mr. Badnall the use of two engines, the Rocket and the Caledonian, and though the temporary defects of the former engine did not at first allow of the experiments being carried to the certainty that the projector desired, they were yet amply sufficient to justify his confidence in the principle. "I consider," says Mr. Badnall, "the results in practice to confirm most fully the advantages shown on the models, and I have not the slightest doubt that it will be found practicable to convey far greater loads from one summit of a curve to another, whose angles do not even exceed that

of the Sutton inclined plane, than any locomotive engine can move upon a level road."

There appears to us to be something extremely feasible in this plan; and being one which can be tested by actual experiment, no extraordinary credulity is involved in giving a serious consideration to its practical applicability. It rests upon one of the simplest laws of nature, which is within the daily experience of almost every individual, but heightened, by the facilities of the railway, into a greater efficiency of operation. We all know that a wheeled vehicle, or any other body, moving freely down a declivity, accumulates a degree of velocity within itself which will propel it a certain distance after it has ceased to be acted upon by the descent of the road. This momentum will be greater in proportion to the greater weight of the body, which is all in favor of the object to which Mr. Badnall purposes to apply it. In order to discover how far the impetus acquired in falling down one slope of an undulating railway would be available in impelling a train of carriages over the next, the experiment is very simple: a certain degree of velocity being given to a load at the foot of an ascent, sufficient to carry it to the summit, we have only to ascertain whether an equal degree of velocity could be given to the load by its own passage down a plane of the same inclination. For this purpose it is only necessary to allow the load to traverse the plane in a reverse direction, and ascertain the velocity with which it again passes the foot of the ascent. The experiments made upon the Sutton inclined plane have fully borne out the correctness of this test, and the result has been so clear and uniform as to leave no doubt as to the soundness of the principle.

Admitting the possibility that the use of steam may be ultimately superseded by this plan, the immense saving which would be accomplished in fuel, carriages, machinery, &c. fills an amazing space in the contemplation, and would be sufficient to counterbalance many attendant disadvantages. Among the principal of these would undoubtedly be the additional capital and labor required for the peculiar construction of such a line of railway, in which a level tract of country, so important a desideratum under the present method, would present one of the most formidable obstacles. We trust, however, that the subject will meet with that serious attention which it unquestionably merits, and in the mean time we publish, with Mr. Badnall's authority, the result of his experiments as recently made.

The following engineers were present, viz. Mr. R. Stephenson, senior, the Messrs. Dixons, Mr. Daglish, and Mr. Badnall, who agreed that the truth and validity of the principle would be effectually determined by the following test:

As great a velocity as possible being attained by the engine *before* reaching a given point on the inclined plane, the *time* was to be accurately ascertained which the train occupied in ascending from that point to a state of rest. The power being then reversed, the time was to be accurately measured which the train occupied in descending from a state of rest to the point from which it had previously ascended. Hence it was obvious, that if the descent was made in less time than the ascent, the velocity generated at the foot of the plane would be proportionably greater than the velocity of the ascending train at the same point, and, consequently, the demonstration would be clear, that the engine and train would not only have ascended to an elevation equal to that from whence it fell, but to a greater one, the extent of which would be in proportion to the velocity attained.

Experiment 1. The Liver engine, and a load of 13 waggons, (weighing in all about 72½ tons,) after traversing a distance of three-fourths of a mile to acquire a sufficient velocity, ran up the inclined plane 278 yards; the time occupied in performing the latter distance being 90 seconds.

Exp. 2. The power being reserved, the engine and train *descended* 278 yards, the time occupied in the descent, viz. from a state of rest to the point from which the time of ascent had been calculated, being only 50 seconds.

Exp. 3. The engine and train having traversed three-fourths of a mile to generate a sufficient velocity, ascended 278 yards in 75 seconds.

Exp. 4. The power being reversed, the descent of 278 yards was accomplished in 40 seconds.

Exp. 5. The ascent of 278 yards was made in 80 seconds.

Exp. 6. The descent of 278 yards was made in 49 seconds.

AVERAGE.

	Total space passed over to generate the velocity.	Time occupied in ascending 278 yards.
Exp. 1,	1,320 yards.	90 seconds.
Exp. 3,	1,320 do.	75 do.
Exp. 5,	1,320 do.	80 do.
Total,	3,960 do.	245 do.
Average,	1,320 do.	81⅔ do.

	Total space passed over in generating velocity on inclined plane.	Time occupied in descending 278 yards.
Exp. 2,	278 yards.	50 seconds.
Exp. 4,	278 do.	40 do.
Exp. 6,	278 do.	49 do.
Total,	834	139
Average,	278	46⅓

It is almost needless to add that these experiments have most fully confirmed the undulating principle, and proved, beyond all doubt, that a locomotive engine and load can traverse a curve or undulation whose two summits are of equal altitude with much greater rapidity, and, consequently, with far greater economy of *time* and *power*, than a level road of proportionate length.

Mr. Badnall having intimated his opinion, that if a velocity of twenty miles an hour were attained at the foot of the plane by two engines, it would be proved by experiment that an engine could move, from one summit of an undula-

tion to another summit nearly, if not quite, *double* the load which that engine was capable of moving on a level, it was determined by the gentlemen present to decide this important question in the course of a few days.

The Undulating Railway.—For the purpose of further testing this important principle, several experiments have been tried since our last publication, of which the subjoined is the result:

It was determined by the engineers who witnessed the last experiments, that another trial should be made to prove the possibility or otherwise of conveying on an undulating line double the load which the engine was capable of drawing, at a like velocity on the horizontal railway.

The only day on which it was thought this experiment could safely and satisfactorily be made was on a Sunday; in consequence of which, on Sunday week a train of loaded carriages, weighing 150 tons, exclusive of the two engines which moved them and their tenders, left Manchester for the Sutton inclined plane.

On this occasion it may, in truth, be said that there never was a more friendly assemblage of mechanical men. It is well known to some of our readers that the French Government have selected a body of the most eminent engineers in that country to visit England, with a view of acquiring all requisite information preparatory to the construction of the intended French lines of railway. These gentlemen, nine in number, were all present; the English engineers who attended being Mr. Robert Stephenson, senior, the Messrs. Daglish, Mr. Dixon, and Mr. Badnall, in addition to whom were nearly all the practical mechanics connected with the railway, and many others, (among whom was Mr. Case, of Summerhill, and Mr. Garnett, of Manchester,) who felt a deep interest in the result.

The following statement is an undeniable corroboration of the favorable opinion which we have before expressed on this subject.

Mr. Badnall had proposed, as an extreme test of the merits of the undulating principle, that meaning:

Experiment 1. Two engines, the Firefly and the Pluto, brought the whole train of waggons, (the length of the train was about 151 yards,) weighing 150 tons, exclusive of engines and tenders, to a given point at the foot of the Sutton inclined plane, the velocity attained at this point being about 19 miles per hour. The Pluto then left the train and the Firefly ascended with the load 575 yards in 116 seconds; the distance traversed by the two engines to generate the velocity before ascending being at least one mile.

Exp. 2. The power of the Firefly being reversed, the engine and load *descended* 575 *yards* in 74 *seconds*; the velocity attained at the foot of the plane being *far greater* than at the same point when *ascending*.

Exp. 3. The Firefly and Pluto having traversed 1 mile to generate a velocity of 15 miles an hour, and the Pluto then leaving the train, at the foot of the inclined plane, the Firefly and load ascended 315 yards in 90 seconds.

Exp. 4. The Firefly's power being reversed, the whole train descended 315 yards in 65 seconds.

Exp. 5. The same engines and load, working about 1¼ miles, attained a velocity of 18 miles an hour; the Pluto left as before, and the Firefly and load rose 457½ yards in 102½ seconds.

Exp. 6. The Firefly and train descended 457½ yards in 80 seconds.

N. B.—On this occasion some delay occurred in reversing the power, which will account for the comparative difference in time.

Exp. 7. The two engines, as before, attained a velocity of 18 *miles* an hour at the foot of the ascent, the Pluto then left the train, and the Firefly shut off her steam, the whole train then rose, *by momentum only*, 332 yards in 70 seconds.

Exp. 8. The train descended (the Firefly working) 323 yards in 66 seconds.

The preceding experiments undoubtedly prove two most important facts, not only that a locomotive engine can convey, on an undulating line, double the load which it is capable of conveying at the same velocity on a level, *but that it can accomplish* this by the employment of *only one half its power*, which last-mentioned fact was decided by the last experiment.

Suspension Railway.—We have frequently been asked how the Suspension Railway is constructed; and how, when constructed, it could be used to any purpose with but *one rail*. Of the suspension railway we had heard much said, but had seen no description from which a correct idea could be formed, and therefore could not give an answer. The great object of the Journal, however, being to furnish information to all who wish it, relative to all kinds of railways, we took measures to obtain, through a friend in Boston, from the patentee, Henry Sargent, Esq., such a description, accompanied with drawings, as will enable any person to understand the principle upon which this cheap and convenient mode of internal improvement is constructed. There is certainly much ingenuity displayed by the inventor, in the construction of his model; and although we are not altogether satisfied that the invention will prove of great importance in practice, yet we consider it well worth the attention of those engaged in the construction of railways, as we are every day more convinced that we are only at the *threshold* of a successful tide of experiment in the construction of railroads. We are, in truth, at this time only *beginning* to learn to construct railways. Twenty years will do for railways what the same period has done and *is now* doing for *steamboats*. Instead of costing *twenty* or *thirty* thousand per mile, and travelling 15 to 25 miles per hour, they will be constructed for one-half the money, and we shall be able to travel at the rate of twenty-five to forty miles per hour. This, we are aware, will, by some, be deemed visionary; yet

a moment's reflection upon the rapidity and extent of the improvements of this country for a few years past, will convince any one that the past warrants even greater expectations than is here predicted.

The *suspension* railway has not heretofore been properly brought before the public. We shall, however, endeavor to obtain, as we trust we shall be able, from the gentleman who has so obligingly furnished us with the following, further descriptions, with accounts of its performances, &c., by which a more correct opinion may be formed of its merits.—[American Railroad Journal.]

SUSPENSION OR SINGLE RAIL RAILWAY.—Imperfect descriptions of this invention have been published in pamphlets and newspapers, in England and America; erroneous impressions, however, have existed in regard to it, which it is the object of the writer to remove. The erection of the Single Rail Railway in England, and similar experiments in this country, have demonstrated this invention to be practicable, and no one doubts its utility. The superior excellence of this Railway, in comparison with all others, lies in its economy; a point which, it cannot be denied, in the ardor of speculation, is not always sufficiently regarded. The very simplicity and cheapness of an article are not unfrequently the cause of its condemnation, since it is neither "dear-bought nor far-fetched:" considerations, which seemingly enhance the value of our possessions. All other advantages being equal, economy must turn the scale in favor of the Single Rail Railway. To avoid the effects of frost and snow, the foundations of all railways, *in this climate*, must be equally deep, and their tops more or less elevated. It is not perceived that this kind of railway is inferior to any other, in its capacity for the transportation of heavy loads; nor in those facilities, by which it accommodates itself to every purpose of transportation. It is manifest that no estimate of any railway, per mile, can be made, without a full knowledge of its location, and of the tonnage, *per wheel*, intended to be transported; for the more the weight is distributed, the lighter and less costly may the railways be. The Single Railway must always be less expensive, other things being equal.

Should the surface of the route be unequal, the plane of the rail may be maintained, by elevating it to a reasonable height on posts of unequal length. From this circumstance, it must appear to the most casual observer, that a great *additional* saving in embankments, culverts, bridges, drains, &c. is claimed for the Single Railway. It has been objected to the Single Railway, that it is occasionally elevated, for the reasons above stated. But is this a comparative objection? Is it not common to both, and to all? The double railway at Quincy passes over intervals, in some places, twenty feet deep; and the rails, and *horse path also*, are elevated accordingly. Yet the railway at Quincy was constructed expressly for the transportation of heavy masses of granite. All writers, on the subject of railways, have adverted to lateral pressure, as a point of great consideration. This effect is inseparable from the very nature of the double rails. But in Single Railways much less allowance is required for lateral pressure: hence it is believed that the single rail can carry more than the double, in proportion to the number of wheels employed; for friction is diminished, in proportion as the lateral pressure is taken away. This lateral pressure causes the flanges of the wheels to rub on the sides of the rails, and corresponding effects are produced, at all the axles of the wheels; for the load on the double rail is immediately upon the axles, communicating its impulses directly and entirely to them.

On the single rail, such is not the case: the load is placed at the ends of the bars, and all motion is necessarily diminished at the axles, which are very *short*, and may be made much *less* than usual, as they are not compelled to bear those shocks which result from lateral pressure. The late experiments in England have demonstrated the superior power of the Single Railway, for the carriage of heavy burthens, attributable, in a great measure, to the causes above recited.

The most perfect steadiness of motion is secured to the carriage, on the Single Railway, by the late additional improvement of the friction rail and rollers: being a slender rail or rod placed on one side only of the supporters, and which bears the pressure of a few pounds only, amounting to nothing more than a slight difference, in the two parts of the load, and causing the heavier side to bear lightly on the friction rail. This pressure amounts to nothing more than that which occurs in adjusting the loads of common carts and trucks, with this difference, that the pressure is maintained longitudinally in the one case, and laterally in the other. It has been supposed, that a precise equipoise of the two portions of the load was indispensable. This is by no means required: a *difference* may exist of two for one, as a leverage takes place, which prevents all ill effects from such cause.

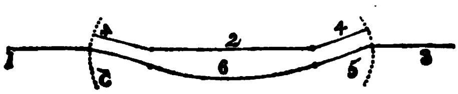
On the Single Railway, the load is more easily put on and taken off. The single rail may be more easily maintained in its proper position; the supporters and their foundations are not likely to be affected, by ordinary causes. The foundations are below the influence of frost, with several feet of heavy stone abutment on both sides, or packed with good gravel, unmixed with perishable earth. Should any change take place, which is not expected, as the pressure of the load is perpendicular, the carriage may still follow the inequalities of the single rail; whilst any considerable change in the position of either rail of the double railway must obviously impede all progress for a time, as effectually as it would be impeded on a common road by a fallen tree, or similar obstruction. This railway may be made of wood, stone, or iron: if wood, various means may be employed for its preservation.

It is not believed that, in point of facilities,

any railway is superior to this which is now recommended. As in other railways, so in this, hills are ascended and descended; roads are crossed, above or below, as they are crossed by canals, and by other modes; the passage of streams is effected on piles, or in *railway boats* particularly adapted to this object. It has been objected to the Single Railway, that, because of its elevated position, it must impede the common travel, which may lie across its path. We have already shown that this elevation is unavoidable, and that all objections, on this score, are general, and applicable to every species of Railway, *in this climate:* for all railways are elevated; the single, on the posts, and the double, on embankments and supporters also.

Crossing places are required, in both single and double railways, at eligible points, and can as easily be made in the former, as in the latter.

The passings or turnouts are effected with as much ease, on the single as on the double railway, as the following sketch may demonstrate:



Let the figures 1, 2, 3, represent the single elevated railway, with the portions 4, 4, thrown back, on simple but strong hinges or joints, which, when closed, form their respective parts of the railway, being fastened by a simple latch.

Figure 6 represents the turnout. 5, 5, two curved portions of the sideling or turnout, moved on strong joints; when closed, as in the sketch, connecting those parts of the rail 1, 3, with the sideling 6. A light carriage, travelling fast from 1 to 3, will at all times pass a slow carriage and take the lead of it, by turning on to the curved rail 5, to the sideling 6, to the main rail 3. The driver of the slow carriage having ample time, without stopping his carriage, to step forward and close the straight bar 4, and open the curved bar 5, with one motion of his hand, they being connected at bottom, (see dotted lines.) The slow carriage passes on to the main rail 2, and the driver replaces the bars as in the sketch, or they may be replaced mechanically; the fast carriage, coming up in the meanwhile, passes forward, the slow carriage being at No. 2. This mode is more particularly adapted to two Single Railways—one for going and the other for returning; but it may be used with advantage travelling both ways on one rail—and is similar to the mode adopted on the double rail, except that there are no cast iron plates with grooves, &c. which probably will not be very convenient in our frosty climate—especially as there are many of them at each sideling. The annexed drawing is a perspective view of the single elevated railway and carriage, which may be raised on supporters of two and a half or three feet on level ground, and more on an uneven surface, as circumstances may require.

The carriage cannot overturn, or incline farther than the friction rail, and may be of any ordinary breadth and length, and braced and strengthened as may be thought proper, and easily adapted to its particular use; and if the centre of gravity is below the top of the rails, the load may be placed higher than the top of the wheels, which, if the above principle be regarded, may be of the largest diameter; and even regardless of this principle, if the friction rail and rollers be employed.

If any objection exist, in relation to the Single Railway, such objection should be very formidable when opposed by considerations of great economy, superior advantages, and peculiar applicability to our own country.

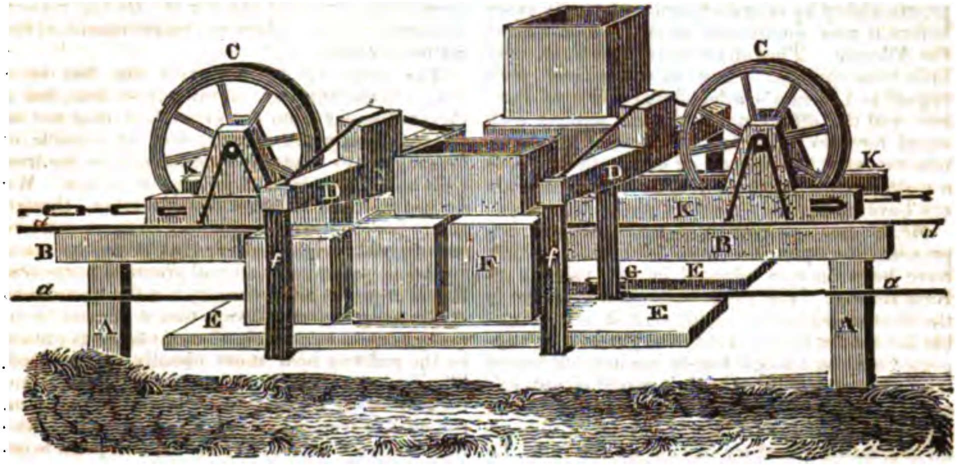
Boston, April 30th, 1827.

Suspension Railways.—Many years ago, after the subject of railway transportation had begun to excite general attention both in England and America, the suspension or single railway was invented *originally* by Henry Sargent, Esq. of Boston, Mass. This invention (for, as the English writers say, it can with no more propriety be called an improvement than the plough can be called an improvement of the spade,) did not for many years attract the attention which its importance appears to deserve, and it remained for a long time without benefit to the public or advantage to the inventor and patentee. Circumstances, which we shall by and by refer to, took place about twenty years ago, which tended to make this railway better known; but at the same time Mr. Sargent found that he was in some danger of being deprived of his fame as inventor, and his right as patentee; and he consequently took some prompt measures to vindicate both.

Among other railways of Mr. Sargent's invention in the United States, there are now two in the county of Suffolk, Massachusetts: one at Chelsea, of a circular form, and a few hundred feet in extent, is used only for purposes of amusement, and is in fact a deviation from his original invention, and no more than an extensive model. The other, at East Boston, is a suspension railway, as lately improved, and has been commenced within a few months; and is not yet entirely completed. This railway is constructed over a marshy piece of ground, full of creeks and ponds, and much more unfavorable than the average surface of the country.

By the help of the plate, which, with the exception of the friction rail, *a a*, represents the railway and car, as first invented, we shall endeavor to convey some idea of the principles of the suspension railroad, and then to point out the improvements which have been subsequently made.

A A are the wooden posts driven or otherwise secured into the earth, upon which the rail is to be supported. The ground in the annexed plan presents a level surface, not requiring any difference in the length of the supporters. But where the surface is uneven, these



can be left of unequal length, and braced every three feet from the top of the rail, according to the undulations of the surface, so that the tops of the supporters shall be on the same level. There have been various expedients suggested for securing these posts in the ground, in order to diminish the tendency to incline from the vertical posture, by the weight and motion of the loads which they are destined to bear. The lower extremities of the posts should be sunk in transverse trenches to a depth of four or five feet, more or less, and placed upon a foundation of hard earth or stones. The sides should be filled up with rubble stones, or otherwise braced. The post should be supported, (in marshy soils,) by at least one strong timber, placed obliquely in the ground and bolted into it, by which it will be stiffened by the oblique timber, and secured from inclining in the opposite direction.

B B is the bearing rail, made of strong timber, of dimensions proportioned to the weight intended to be supported. This rail is to be firmly fixed upon the supporters with mortice and tenant. When the wheels C C are intended to be guided with flanges, it is advisable to have the top of the rail shod with iron, *d d*, in order to prevent the flanges from fraying, or, as it is called, brooming the sides of the rail, and thereby wearing it out and making it uneven. C C are the wheels, placed one before the other, in a direct line on the rail, and provided with flanges on either side, to keep them in position. From the axles of these wheels are suspended the horizontal bars or frame work, K K, to which the cars for passengers or merchandize are connected by the transverse bars D D, and strong, inflexible frame *ff*, so that the cars are balanced on each side of the rail, like the bags of a pack saddle. F is the loading placed on the cars in readiness for transportation. It might be objected by persons not acquainted with mechanics, that this method of transportation is unsafe, because there being but one line of wheels, the cars would be overturned, unless the load is very equally balanced on each side of the rail. It is of course better that the load should be so balanced, but it could very easily be shown in practice it is impossible that the cars can be overturned when the materials hold together. When one side is heavier than the other, a slight inclination of the heavier side takes place, and that is all; for as soon as the heavier side begins to incline, it approaches the centre of gravity, and is thus continually losing its tendency to incline, and cannot incline further than the supporters, as the car is longer, &c.; while, on the other hand, the lighter side is receding from the centre of gravity, and is consequently gaining power to balance the other by the leverage which takes place. We have frequently seen that a person carrying a single pail of water will extend his disengaged arm at right angles with his body, and by this simple instinctive motion, one arm alone is made to balance the other with a weight of twenty pounds at the end of it. A very great additional security is derived from the very low position of the centre of gravity, owing to the load being placed below the wheels, instead of above or on a level with them, as is the case in common carriages. It is also impossible that the car should be overturned in case of the breaking of the axles, for the load being on each side of the rail, and below the centre of gravity, the body of the car would fall but one-fourth of an inch, and slide on the rail, if in motion, and there be firmly supported. Such are the general principles of the suspension railway as originally invented by Mr. Sargent.

A few years ago the plan of a railway precisely similar in its nature was submitted to the British public by H. R. Palmer, Esq., and it has been generally noticed in English scientific works as Palmer's Patent Suspension Railway, no acknowledgement being made of Mr. Sargent's prior claim. It is impossible to say whether the English inventor had taken any hints, either directly or indirectly, from the American. We do not know that he had ever heard of it, but it is very certain that the latter could have had no possible assistance from the former, because he had demonstrated its

practicability by actual experiment, many years before it was mentioned on the other side of the Atlantic. This discussion, however, is of little consequence. Newton's argument, with regard to Leibnitz's alleged discovery of fluxions and the differential calculus, applies with equal force to this case. Whether Mr. Leibnitz invented it after me or had it from me, is a matter of no consequence, as second inventors have no rights.

Mr. S. has subsequently made several improvements upon his first invention, which have been in part adopted in his railway at East Boston. The most important of these is the friction rail, *a a*. Although it is impossible for the car to be overturned, yet as it is supported only on a single line of motion, but on the whole breadth of the wheel, it would be apt, except in cases where the load is composed of inert matter, and very nicely balanced, to have an oscillating vibratory motion on the rail. To prevent this the small rail *a a*, made of wood, is fastened on each side of the supporters A A, and to prevent friction from the sides of the car, a wheel *b*, on a vertical axis, is placed under the floor of the car, to run horizontally upon the rail. The pressure upon this rail is very trifling, amounting to much less than the difference of weight between the two sides of the loaded car, because the overloaded side having a tendency to descend in a perpendicular line, the oblique pressure upon the friction rail is smaller than the whole tendency of the loaded side to descend. The rail may therefore be of a small size, and can be furnished at a very trifling additional expense; and by means of it, the car, even with a shifting and varying load, will be kept as steady as if upon a double track.

Another great improvement has been suggested with regard to the wheels. If the wheels are kept on the main rail by flanges, as in the plate, it is absolutely necessary that the rail should be shod with iron, which causes a very great additional expense. If this is not done, the continual friction of the flange on the edge of the rail will cause it to fray or broom as before stated. To obviate this difficulty, the wheels may be made wider than the rail, without flanges, to run freely upon the smooth surface of the rail, and to keep their direction, guided by rollers, of which the place only can be seen in the plate, may be placed horizontally at *c c*, to run on the side of the rail, thus answering every purpose of the flange, but with a much smaller degree of friction, and with a saving of the whole expense of the iron guard for the rail.

A due regard being had to the principles above stated, the cars intended to be put upon the railway may be varied according to the nature of the articles to be transported, and the fancy or taste of the proprietor. The railway at East Boston is, as we have before said, built over a tract of marshy land of a peculiarly unfavorable nature. The supporters are piles driven through the marsh to a stratum of blue clay beneath, and strengthened by oblique braces. Being merely an experiment, the cars to be placed upon it are intended only for the transportation of passengers to a place of entertainment, at the farther end of it.

The only serious objection that has been made to the suspension railway is, that, being elevated so far from the ground, it may not be so sufficiently permanent, and so capable of bearing heavy loads, at a *rapid* rate, as the iron rails which are elevated only a few inches. We do not wish to discuss this question, though many persons, whose opinions in these matters are of great weight, believe that it may be made sufficiently permanent for all practical purposes. But it is not at all necessary for the usefulness of the suspension railway, that it should be in every respect as capable of enduring heavy loads as the railway now most usually constructed. The important question is, whether, taking into consideration the expense of its construction, the cost of transportation upon it will be less than upon an ordinary road. If this point is established, as it has been, beyond all doubt, its importance is manifest. There are many parts of the United States where the increase of population and of business calls for greater facilities of communication; yet the travel is not sufficient to support the enormous expense of the double iron railway. There are other sections so rugged and uneven, that whatever might be the amount of travel, it could not pay the expense of embankments, excavations, and other works necessary for attaining the level required for the road. In all such cases the suspension road, on account of its comparatively trifling expense, can be used to great advantage. The average cost of a suspension railroad, built with prudence and economy, extending over a country the surface of which presents no peculiar advantages or disadvantages, is about one quarter of that of the double track iron road now in use, and this difference is increased in proportion as the country, over which the road is to be constructed, is more rugged and uneven than usual. Now suppose that the suspension road is only capable of bearing one third of the momentum which the other road can bear, (and this is certainly a greater allowance than it would be necessary to make in practice,) yet the cost being one fourth that of the other, and its power one third, it follows, of course, that the suspension road would be much the most economical.

In a new country, therefore, where means are limited, it must be of immense advantage. Its merits have not hitherto been generally known. It has been but very little used in England, probably on account of the high price of timber, and on this side of the Atlantic we have been slow to adopt suggestions that have not been proved and tested by experiment. But it is now getting into more extensive favor in those parts of the country where timber is abundant. It will, no doubt, in a short time, prove a most important method of inland transportation.

Strength of Locust.—Experiments with seasoned locusts an inch in diameter resulted in suspending to it 20,000 lbs. nearly one-third the strength of iron.

State of Manufactures in America—Evidence of Mr. James Kempson, of Philadelphia, Cotton Manufacturer. [From the Factory Commissioners' Report in Great Britain.]

Most of our readers, doubtless, have heard of the struggle that has been going on between capitalists in England and the friends of amelioration of the condition of the working classes in that country, particularly of those who have not arrived at maturity, and are in fact in a much worse condition than most slaves in any part of the world. The philanthropists succeeded so far as to obtain a parliamentary commission of inquiry, which was followed up by the introduction of a bill into the House of Commons, regulating the hours of work in factories for all boys and girls under fourteen years of age, we believe. That bill passed the House of Commons, but the *House of Incurables*, (the Lords,) as they have been so well termed, thought fit to reject it.

In the course of the investigation, Mr. Kempson, of Philadelphia, was examined, and his testimony we now insert, and we are sure it will be perused with feelings of pride by all our readers.

With what extent of manufactures have you been conversant in America?—I have been acquainted with the manner of conducting manufactures in most of the manufacturing states.

What number of workmen do you employ in your manufactory?—About four hundred.

What is the lowest age of persons in your employment? None under nine.

Have you many about nine years of age? —We have a great many between nine and twelve. About one-fifteenth of the persons employed in the United States are under twelve years of age.

What is the utmost extent of your daily working hours?—The actual number of working hours averages throughout the year twelve hours of actual work; at some seasons it is nearly fourteen, and at others it is little more than ten.

Is the labor for fourteen hours often continuous for many successive days?—We change the period by the light. We never light up in the mornings, nor in the evenings, from the 20th of March to the 20th of September; and from the 20th of September to the 20th of March following, we work until eight o'clock of the evening.

Do the children work during the whole hours of work?—Yes; we never make any difference on account of age.

Have any complaints been made in the United States as to the propriety of such extent of labor for children?—There have been newspaper complaints, originating probably from the workmen who came from this country to the United States; but among our workmen there is no desire to have the hours of labor shortened, since they see that it will necessarily be accompanied by a reduction of their wages.

What proportion of the persons employed are natives of the United States?—Throughout New-England, which are considered the manufacturing states, above eight-tenths of the persons employed are natives of the United States.

Are many of the remaining two-tenths English workmen?—The greater portion of them; but, as a general rule, they do not like to take English workmen in the New-England factories.

Why do they not like the English workmen?—Because they are so dissipated and so discontented.

Is this their general character in the United States?—Yes; after they have been some time in the country, they are noted as the greatest drunkards we have. The wholesale price of whiskey is, with us, nine pence per gallon, and they appear not to be able to overcome the temptation. Our own workmen are *better educated, and more intelligent, and more moral, and refrain more from sensual indulgence.*

How does the discontent of the English workmen, of which you have spoken, usually manifest itself?—In the workmen becoming masters, in strikes, and demands for wages, almost always ill-considered, with which the master cannot comply, and which grievously interfere with his commercial operations; their ignorant expectations generate ill will and hostility towards the masters.

Are no jealousies entertained by the American workmen towards their masters?—In America we never hear the word master; they usually speak of the manufacturer by name, or as their employer, and view him rather as a tradesman to whom they dispose of their labor, than as a person having a hostile interest. There are no jealousies between American masters and workmen, of the nature of those which appear to prevail between the English workmen and their employers.

Are there no combinations to keep up wages in America?—None amongst the American cotton manufacturers.

Are there no combination laws?—None.

To what do you attribute this state of things among the American workmen?—To their superior education, to their moral instruction, and to their temperate habits.

Have you any national system of education?—We have public schools, supported partly by state funds, and partly by bequests. All children have the privilege of attending.

Do they, in point of fact, very generally attend in the manufacturing states?—They universally attend; and I think that information is more universally diffused through the villages and the whole community of the New-England states, than amongst any other community of which I have any knowledge.

What is the general view taken of these schools by the manufacturers and persons of wealth in America?—From their experience they deem them of the greatest importance to the welfare of the state. They are encouraged by the state governments and all the leading persons of the state.

How do the children whom they employ obtain education?—The manufacturers are always anxious that the children should absent themselves from the manufactory during two or three months of the year to attend the schools. The manufacturer very frequently suggests to the parents the necessity of the children being taken to school. The sending the child to school is generally an inconvenience to the manufacturer.

Is the inconvenience of the children going to school such as to increase the cost of production?—I do not think it does increase the cost of production. The only inconvenience is in the trouble of getting other hands. We think the advantage of their being educated more than counterbalances that trouble.

What is the nature of this national education?—It consists in reading, writing, arithmetic, grammar, and geography.

Do the workmen read much?—Yes; we have frequently a difficulty in keeping books out of the hands of some of them when they should be engaged in their work.

What sort of books do they usually read?—Voyages and travels are the most favorite reading with them. They are also great readers of newspapers, and some of the workmen take two or three.

Then what is the cost of each newspaper?—Less than 2d.

What wages do you usually give?—We employ them by the year. A person ten years old would get 3s. a week; a person twelve years old, 4s. a week; fourteen years, 5s.; sixteen, 6s.; eighteen, 8s. Those more advanced in years would earn 10s. The smaller children in the carding room are those who earn 3s. a week; those attending the drawing frames earn from 5s. to 6s.; those who attend the roving frames earn 8s. a week; girls attending the throstle-frames earn from 5s. to 8s.; machine makers earn about 5s. a day; mule spinners earn about 5s. a day; overlookers earn from 5s. to 6s. a day; assistant overlookers from 3s. to 4s. a day.

What do the men pay for board when they board with families?—From 6s. to 7s. per week.

What do young women pay?—Five shillings per week.

And children?—They generally board with their parents.

What is the description of fare usually obtained by the American workmen?—Nearly the same articles as those used by the more wealthy classes. They have as much meat as they wish twice a day; they have fruit pies at every meal; in short, as I have stated before a committee of the House of Commons, I have paid eight shillings a week for board, lodging, and washing, and live as well as I could live in equal lodgings in a village in England for two pounds a week.

What is the difference in the effects between fourteen and ten hours' work on the health of the persons employed, so far as you have observed in America?—When they worked twelve hours, the thermometer stood at 103°, and they were then more unhealthy than when they were working twelve hours in the winter season; but I believe that those who were in the mill enjoyed better health, both during summer and winter, than those who worked at agricultural employments, or than those who were idle. I state this from my own observation. I resided at the house of a medical practitioner, who had the practice of most of the persons who were employed at the mill, as well as of most of those who were employed in agriculture, and my own observation was corroborated by his reports, as to the sickness prevalent. Thus I received my impression of the superior healthiness of those engaged in the factory.

Are the American children stronger or weaker than the children of the English operatives?—The youngest American children are, I think, rather the strongest. Since November last I have been engaged in visiting the manufactories here, and I should say, that, on the whole, the children are rather stronger in America than they are here.

Would you call the English manufacturing children, as a body, unhealthy?—No; I

should almost think they are as healthy as the children in the agricultural districts. I have noticed that the children of a factory in a village usually look better than the children of a factory in a town. I should think this might be accounted for from the difference of the residences in the villages as compared with the residences in the towns, where they appear to work longer hours.

Does your experience in America of the short as compared with the long hours, enable you to form any judgment as to the probable effects upon the health or comforts of the workmen of a reduction of the working hours to ten in this country?—The climate is so different that I can form no judgment. The longest hours of our work are during periods of the most oppressive heat.

Do the children attend school at any particular period?—No; they attend during one period as much as another.

Do they select the times of the long or of the short hours?—I do not think they make any selection as to the hours of work. If they selected the time of the long hours they would have the night-work of the winter. They would, I think, as soon have the longer hours of the summer to avoid night-work.

What is the nature of your manufacture?—Spinning and weaving coarse yarn.

Is any of it for exportation?—Yes.

To what markets?—South America, West and East Indian markets.

Do you find that you can compete successfully with British manufactures of a similar kind in the same markets?—Yes; although we labor under some disadvantages that you do not.

What disadvantages?—One of our disadvantages is, that in the East India markets we have to pay a duty which you do not pay; and we have to pay six per cent. interest on the advance, which is considerably higher than you have to pay. A further disadvantage we labor under is, that whereas a large proportion of your manufacturers export their goods direct, and are therefore not subject to any commission on the shipment, our manufacturers never export on their own account, and the shipping merchant starts with a commission of five per cent. on the price which the manufacturer receives.

Have the goodness to explain the nature of the charge of five per cent. commission to which the article is subject prior to shipment?—The manufacturer sends his goods to a commission merchant at the shipping ports, who receives five per cent. for selling and guaranteeing.

And notwithstanding these drawbacks you can maintain the competition with us?—Yes; and not so only, but are gaining ground upon you, and have already excluded you from some markets.

From what markets?—Some of the Mexican and South American. Several of our largest establishments have large contracts pending for a long time forward for those markets, at prices which would not give a fair return to the British manufacturer, but are very profitable to our manufacturers.

You say this from having ascertained, during your visit to Manchester and other manufacturing districts in this country, the exact state of the relative prices?—Yes.

What are the present relative prices of yarn,—for instance, of No. 16?—No. 16, water twist, made entirely of good cotton, sells in the United States at 10½d. per lb.; in England, No. 16, yarn, made from a mixture of waste twists, and a small quantity of boweds, sells at 11d. per lb. The price of 10½d. in America is from the commission merchant, who receives 5 per cent. for selling it on eight months' credit; and the price of 11d. in England is on three months' credit from a manufacturer.

Do you consider the price of 10½d. to be remunerative to the American manufacturer?—Decidedly so.

And do you consider that you have equal advantages in weaving?—Yes.

Have you the means of showing what is the comparative cost of weaving in the United States and in this country?—Yes, I can show it by the following statement:

	United States		England.	
Interest on dressing machine,	£2 11		£1 12	
Do. twelve power looms,	8 6	6 per cent.	4 10	
Cost per annum of one horse power,	3 10		12 10,	at 5 per cent.
Cost of dressing 3,756 pieces,	23 9		46 18	
Cost of weaving,	125 4		156 10	
American, 10½d. per piece,	£163 0	—England, 11d.	£222 0	

How do you account for the difference between £3 10s., which you state as the cost per annum of one horse power, and £12 10s. as the cost in England?—In America it is water power, which exists there in great abundance, at a very low rent, even in the best

situations; whereas in this country it is mostly steam power, or, if water power, at a very high rent.

What do you reckon will be the effect on the cost of production of your manufacture, if the working hours of your mills were, by an act of your legislature, to be reduced from an average of 12 to 10 hours?—They would be increased in price about ten per cent.

Have you the means of showing how the reduced hours of work would operate on the cost of production?—Yes, by the following statement:

Estimated value of the cotton manufacture of the United States—Wages, £2,087,400; cotton, £1,800,000; profit and interest, £1,529,266; annual value, £5,416,666. Now, supposing a legislative enactment to limit the working hours to ten, and in consequence of foreign competition the value of the goods must not be increased, and in order to make the same quantity he must employ one sixth more hands, and the interest on this increased investment must be deducted from the wages, for no other item can be reduced; taking the interest, wear and tear, at 8 per cent. upon this further investment, the amount will be £112,819.

£2,087,400 wages, as before
112,819

£1,974,581 wages after.

The number employed previous to this supposed alteration was 62,157, receiving upon an average annually £33 10s. The number increased to 72,572 would receive £27 4s. Supposing the workmen not reduced in their wages, the amount would stand: Wages, £2,429,998; interest on the investment, £112,819; cotton, £1,800,000; interest and profit, £1,529,266; total, £5,872,073.

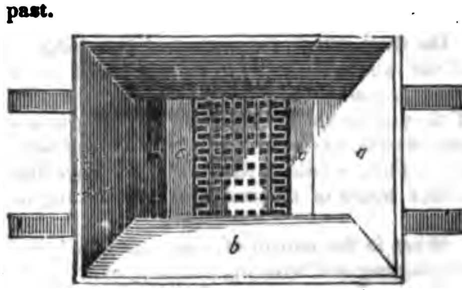
What, in your opinion, would be the effect of a compulsory limitation of the working hours in this country to ten instead of twelve, upon the manufactures of the United States?—It would tend much to their increase. I think we should not only be able to undersell you in markets abroad, but even in your home market.

Do you mean after paying the present import duty into this country of ten per cent?—Yes.

Do you not think that we should be under the necessity, in such a case, of adopting your tariff system?—Most undoubtedly, if you wished to preserve even your home market.

India Rubber.—More than fifty-two thousand pounds of caoutchouc, or India rubber, were exported into England in 1830, being nearly double the quantity brought during the preceding year. Its price is from 1s. 6d. to 2s. 3d. per lb. The duty upon it is 5d. per lb. The increase in the demand is to be attributed to the application of this substance as an article of general utility.

Curd-Breaker for Skim Milk Cheese.—We have heard of many curious experiments adopted by housewives, and some of them highly ludicrous, to facilitate the breaking of curd. This simple instrument is a happy substitute for every sort of expedient. With it any boy or girl can break the curd arising from the milk of eight or ten cows in fifteen minutes. It is not intended for the making of sweet milk cheeses, the curd of which should be broken very gently. It was invented by Mr. Robert Barlas, Gilmour Place, Edinburgh, and has been in use on some farms for several years past.



a, fig. 1, is a hopper of wood, 17½ inches by 14 on the top, and 10 inches in depth. *b* is a cylinder of hard wood 6¾ inches in length, and 3½ in diameter. It is studded with hard wood square pegs of a quarter of an inch in the side, cut square at the ends, and projecting three-eighths of an inch. There are eight teeth in the length, and fifteen in the circumference, of the cylinder, 120 teeth in all. It revolves on a round iron axle 12 inches in length, and is moved by the crank-handle *d* in fig. 2; *c c* are

two wedge-shaped pieces of hard wood, made to fill up in some degree the space between the side of the hopper and the cylinder. These pieces rest on a slip of wood nailed to the lower rim of the hopper, to keep them in their place. The face of these is studded with nine teeth of hard wood, similar to those on the cylinder, in a horizontal position, but so placed as to embrace those of the cylinder at opposite sides. The stand *e*, fig. 2, can be made of any length, to suit the breadth of the tub into which the curd is broken. The implement is used in this manner: place it over a tub, heap the hopper *a* with curd, and turn the winch *d* in ei-

after direction, and the curd will fall quite small broken into the tub. While one hand is moving the machine, the other can press the curd gently down into the hopper. As cleanliness is a matter of the greatest importance in cheese-making, the internal parts of this machine being loosely put together, can easily be taken to pieces to clean. The cylinder axle rests on two hard wood plumber-blocks, *f*, fig. 2, one on each side, which slip out of their groove. They are held in their working position by the thumb-catch *g*, sunk flush with the bottom of the stand *e*, one over each plumber-block. The wedge-shaped pieces *c c*, fig. 1, come out. To prevent the curd working out of the sides of the axle, the cylinder is set a little at both ends into the sides of the hopper. The dotted lines in fig. 2 will give an idea how the internal part of the machine is constructed. Only one tooth is represented on the cylinder by the dotted lines, to show the position of the whole.—[Edinburgh Quarterly Journal of Agriculture.]

History of Chemistry. [Continued from Vol. II., page 251.]

"By arranging metals," says Dr. Ure, "according to the degree in which they possess the obvious qualities of unalterability, by common agents, tenacity, and lustre, we also conciliate their most important chemical relations, namely, those to oxygen, chlorine, and iodine; since their metallic pre-eminence is, popularly speaking, inversely as their affinities for these dissolvents. In a strictly scientific view, their habitudes with oxygen should perhaps be less regarded in their classification, than with chlorine; for this element has the most energetic attractions for the metals. But, on the other hand, oxygen, which forms one-fifth of the atmospheric volume, and eight-ninths of the aqueous mass, operates to a much greater extent among metallic bodies, and incessantly modifies their form, both in nature and art." Now, the arrangement we have adopted in the following list of these bodies will indicate very nearly their relations to oxygen. As we progressively descend, the influence of that beautiful element progressively increases. Among the bodies near the top of the table, its powers are subjugated by the metallic constitution; but among those near the bottom, it exercises an almost despotic sway, which Volta's magical pile, directed by the genius of Davy, can only suspend for a season. The emancipated metal soon relapses under the dominion of oxygen.

The number of metals at present known amount to thirty, if we except the bases of the alkalies and earths, and one or two other substances, which some individuals wish to rank among these bodies; but as they are not generally acknowledged to belong to this class of substances, we shall not include them in the following table:

	Names.	Spec. Grav.	Precipitants.
1	Platinum	21·47	Mar. ammon.
2	Gold	19·30	Sulph. iron Nitr. mercury
3	Silver	10·45	Common salt
4	Palladium	11·8	Prus. mercury
5	Mercury	13·6	Common salt Heat
6	Copper	8·9	Iron
7	Iron	7·7	Succin. soda, with perox.
8	Tin	7·29	Corr. sublim.
9	Lead	11·35	Sulph. soda
10	Nickel	8·4	Sulph. potash ?
11	Cadmium	8·6	Zinc
12	Zinc	6·9	Alk. carbonates
13	Bismuth	9·88	Water
14	Antimony	6·70	Water Zinc
15	Manganese	8·	Tartr. pot.
16	Cobalt	8·6	Alk. carbonates
17	Tellurium	6·115	Water Antimony
18	Arsenic	8·35 ? 5·76 ?	Nitr. lead
19	Chromium	5·90	Nitr. lead
20	Molybdenum	8·6	Nitr. lead ?
21	Tungsten	17·4	Mur. lime ?
22	Columbium	5·6 ?	Zinc, or inf. galls
23	Selenium	4.3 ?	Iron Sulphite amm.
24	Osmium	?	Mercury
25	Rhodium	10·65	Zinc ?
26	Iridium	18·68	Zinc ?
27	Uranium	9·0	Ferropr. pot.
28	Titanium	?	Inf. galls
29	Cerium	?	Oxal. amm.
30	Wodanium	11·47	Zinc
31	Potassium	0·865	Mur. plat. Tart. acid.
32	Sodium	0·972	
33	Lithium		
34	Calcium		
35	Barium		
36	Strontium		
37	Magnesium		
38	Yttrium		
39	Glucinum		
40	Aluminum		
41	Thorinum		
42	Zirconium		
43	Silicium		

The first 12 metals in the table are malleable, as also the 31st, 32d, and 33d, in their solid or congealed state.

The first 16 are capable of being converted into oxides, which are neutral salifiable bases.

Those marked 17, 18, 19, 20, 21, 22, and 23, are capable of being acidified, by combination with oxygen.

Of the oxides of the rest to the 31st, very little is known.

The others form with oxygen the alkaline and earthy bases.

Having given as full a list of the metals as it is possible to obtain, and having stated pretty fully their general and characteristic properties, we shall now begin to describe them individually, and to state their particular properties. The malleable metals being the most valuable, as well as the most useful, we shall begin by describing them first.

Of Gold.—Gold seems to have been known from the very beginning of the world. Its properties and its scarcity have rendered it more valuable than any other metal.

It is of an orange red, or reddish yellow color, and has no perceptible taste or smell. Its lustre is considerable, yielding only to that of platinum, steel, silver, and mercury.

Its specific gravity is 19·3.

No other substance is equal to it in ductility and malleability. It may be beaten out into leaves so thin, that one grain of gold will cover 56¾ square inches. These leaves are only $\frac{1}{282000}$ of an inch thick. But the gold leaf with which silver wire is covered is only $\frac{1}{12}$ of that thickness. An ounce of gold upon silver wire is capable of being extended more than 1300 miles in length.

Its tenacity is considerable, though in this respect it yields to iron, copper, platinum, and silver. From the experiments of Sickingen, it appears that a gold wire 0·078 inch in diameter, is capable of supporting a weight of 150·07 lbs. avoirdupoise, without breaking.

It melts at 32° of Wedgwood's pyrometer.* When melted it assumes a bright bluish green color. It expands in the act of fusion, and consequently contracts while becoming solid more than most metals: a circumstance which renders it less proper for casting into moulds.

It requires a very violent heat to volatilize it; it is, therefore, to use a chemical term, exceedingly *fixed*. Gasto Claveus informs us, that he put an ounce of pure gold in an earthen vessel, into that part of a glass-house furnace where the glass is kept constantly melted, and kept it in a state of fusion for two months, yet it did not lose the smallest portion of its weight. Kunkel relates a similar experiment attended with the same result; neither did gold lose any perceptible weight, after being exposed for some hours to the utmost heat of Mr. Parker's lens. Homberg, however, observed that when a very small portion of gold is kept in a violent heat, part of it is volatilized. This observation was confirmed by Macquer, who observed the metal rising in fumes to the height of five or six inches, and attaching itself to a plate of silver, which it gilded very sensibly; and Mr. Lavoisier observed the very same thing when a piece of silver was held over gold, melted by a fire blown by oxygen gas, which produces a much greater heat than common air.

After fusion it is capable of assuming a crystalline form. Tillet and Mongez obtained it in short, quadrangular, pyramidal crystals.

Gold is not in the least altered by being kept exposed to the air; it does not even lose its lustre. Neither has water the smallest action upon it.

It is capable, however, of combining with oxygen, and even of undergoing combustion in particular circumstances. The resulting compound is an *oxide of gold*. Gold must be raised to a very high temperature before it is capable of abstracting oxygen from common air. It may be kept red hot almost any length of time without any such change. Homberg, however, observed that when placed in the focus of Tschirnhaus's burning glass, a little of it was converted into a purple-colored oxide; and the truth of his observations were confirmed by the subsequent experiments of Macquer, with the very same burning glass. But the portion of oxide formed in these trials is too small to admit of being examined. Electricity furnishes a method of oxidizing it in greater quantities.

If a narrow slip of gold leaf be put, with both ends hanging out a little, between two glass plates tied together, and a strong electrical explosion be passed through it, the gold leaf is missing in several places, and the glass is tinged of a purple color by the portion of the metal which has been oxidized. This curious experiment was first made by Dr. Franklin; it was confirmed in 1773 by Camus. The reality of the oxidizement of gold by electricity was disputed by some philosophers, but it has been put beyond the reach of doubt by the experiments of Van Marum. When he made electric sparks from the powerful Teylerian machine pass through a gold wire, suspended in the air, it took fire, burnt with a green-colored flame, and was completely dissipated in fumes, which when collected proved to be a purple-colored oxide of gold. This combustion, according to Van Marum, succeeded not only in common air, but also when the wire was suspended in hydrogen gas, and other gasses which are not capable of supporting combustion. The combustion of gold is

* According to the calculation of the Dijon academicians, it melts at 1298° Fahrenheit; according to Mortimer at 1301°.

now easily effected, by exposing gold leaf to the action of the galvanic battery. Dr. Thomson made it burn with great brilliancy, by exposing a gold wire to the action of a stream of oxygen and hydrogen gas mixed together and burning. Now in all cases of combustion the gold is oxidized. We are at present acquainted with two oxides of gold: the *protoxide* has a *purple* or violet, the *peroxide* a *yellow* color.

Of these, the *peroxide* is most easily procured; it is therefore best known. It may be procured in the following manner: equal parts of nitric and muriatic acids are mixed together,* and poured upon gold; an effervescence takes place, the gold is gradually dissolved, and the liquid assumes a yellow color. It is easy to see in what manner this solution is produced, for it is worthy of remark, that no metal is soluble in acids till it has been reduced to the state of an oxide. There is a strong affinity between the oxide of gold and muriatic acid. The nitric acid furnishes oxygen to the gold, and the muriatic acid dissolves the oxide as it forms. When nitric acid is deprived of the greater part of its oxygen, it assumes a gaseous form, and flies off in the state of *nitrous gas*. It is the emission of this gas which causes the effervescence. The oxide of gold may be precipitated from the nitro-muriatic acid, by pouring in a little potash dissolved in water, or even by lime water. It subsides slowly, and has a yellowish brown color, and sometimes, indeed, approaches to black. When carefully washed and dried, it is insoluble in water and tasteless. When this oxide is moderately heated it becomes purple. A stronger heat expels the whole of the oxygen, and reduces it to the metallic state.

The properties of the *protoxide* of gold are but little known. It is formed when the metal is subjected to combustion, or to the action of electricity, and likewise by exposing the peroxide to the proper degree of heat, or even by placing it in the rays of the sun. Its color is purple. Various preparations containing it are used in the arts, which will be noticed afterwards.

Hitherto gold has been united artificially to none of the simple combustibles except phosphorus. Hydrogen and charcoal are said to precipitate it from its solutions in the metallic state.

Sulphur, even when assisted by heat, has no action on it whatever; nor is it even found naturally combined with sulphur, as is the case with most of the other metals, yet it can scarcely be doubted that sulphur exercises some action on gold, though but a small one: for when an *alkaline hydro-sulphuret* is dropped into a solution of gold, a *black powder* falls to the bottom, which is found to consist of gold and sulphur, either combined or intimately mixed; and when potash, sulphur, and gold, are heated together, and the mixture boiled in water, a considerable portion of gold is dissolved. Three parts of sulphur and three of potash are sufficient to dissolve one of gold. The solution has a yellow color. When an acid is dropped into it, the gold falls down, united to the sulphur, in the state of a reddish powder, which becomes gradually black.

Gold does not combine, as far as is known, with any of the simple incombustible bodies.

But gold combines readily with the greater number of the metals, and forms a variety of alloys.

This metal is so soft that it is seldom employed in a state of purity. It is almost always mixed with small quantities of copper and silver. Goldsmiths usually announce the purity of the gold which they sell in the following manner: pure gold they suppose divided into 24 parts, called *carats*. Gold of 24 carats means pure gold; gold of 23 carats means an alloy of 23 parts gold, and one of some other metal; gold of 22 carats means an alloy of 22 parts of gold, and two of another metal. The number of carats mentioned specifies the pure gold, and what that number wants of 24 indicates the quantity of alloy. Thus gold of 12 carats would be an alloy containing 12 parts gold and 12 of some other metal. In this country the carat is divided into four grains; among the Germans into 12; and by the French it was formerly divided into 32.

OF PLATINA.—Platina, or platinum, was not known by chemists till the middle of the eighteenth century. Under this name, however, which is of Spanish origin, and signifies *little* or inferior *silver*, some white trinkets of little estimation were sold, before the metal was distinctly known. Antonio de Ulloa, a Spanish mathematician, who accompanied the members of the French academy, in their famous voyage to Peru, for the purpose of ascertaining the figure of the earth, first gave something like a precise notion of it, in the account of his voyage published at Madrid in 1748. It is observed, that Mr. Charles Wood, an English metallurgist, brought some of it from Jamaica in 1741. This gentleman related some experiments on this new metal in the Philosophical Transactions for 1749 and 1750.

* This mixture, from its property of dissolving gold was formerly called *aqua regia* (for gold among the alchymists was the king of metals); it is now called *nitro-muriatic acid*.

These first experiments, which announced very extraordinary properties, made a great noise in Europe, at a period when the discovery of a metal, particularly one so singular as this appeared to be, was a phenomenon beyond what any one had dared to hope. The great chemists of Europe were then eager to examine platina, and investigate its distinguishing characters. Scheffer, a Swedish chemist, gave the first accurate series of experiments on this metal, in the Memoirs of the Academy of Stockholm, in 1752; in consequence of which, he ranked this metal near gold for its properties, and called it *white gold*. Lewis, an English chemist, to whom we are indebted, among other things, for a history of silver and gold, very complete for the time, made a very extensive and regular series of experiments on platina, which he published in the Philosophical Transactions for 1754. In the Memoirs of the Academy of Berlin for 1757, Margraff gave an account of his experiments on this metal. All these early labors were collected and compared by Morin, in a work he published in France, in 1758, under the title of *Platina, White Gold, or the Eighth Metal*. This is a methodical compilation of all that had been done previous to that period.

After these researches, already very numerous, Achard, Guyton, Lavoisier, and Pelletier, successively published methods of obtaining platina pure, and of fusing it, and new information respecting its combinations.

From these combined labors we have acquired a considerable knowledge of the properties of platina, though there are still many things desirable for completing the history of this metal. The pneumatic system has done nothing with regard to platina, except teaching us to place it on a level with gold, in respect to its difficult oxidation, its little affinity for oxygen, and its consequent unalterability by the majority of other substances.

Platina, when purified, is of a less beautiful white than silver, and verging a little towards the grey color of iron. When burnished, it has a blackish tint, and not the white lustre of silver. Its unpolished parts are somewhat grey and dull. Its appearance is not so brilliant and pleasing as that of silver, or gold; and most men, though likely to confound it with other metals, would not form from the sight of it the same idea as of those two precious metals which attract their eyes and excite their admiration, or attach to it the same value.

This metal is the most dense and heavy of all natural substances. When it is slightly hammered or forged, its specific gravity is 21·5, and after being well hammered it is 23.

The elasticity of platina appears to be pretty considerable. Its ductility is great; though it is far from being easily wrought, it is reduced to very slender wires, and very thin leaves. Guyton gives it the second rank in this respect, placing it between gold and silver. It is easily bended, and the resistance and cohesion of the plates fabricated of it will, at some future period, admit a great number of uses to be made of it of high importance. The same chemist made the most accurate experiments on its tenacity, or the cohesion of its particles. In this point, he assigns it the third rank, after iron and copper, and before silver and gold.

Platina, like all other metals, heats quickly, and is a very good conductor of caloric. Borda found that its dilatation is $\frac{1}{92000}$ to a degree of Reaumur's, and $\frac{1}{116000}$ to a degree of the decimal thermometer. Of all metals it is most intractable in the fire and the most difficult to fuse. It goes beyond iron and manganese in this property. Guyton estimates its fusibility at a degree yet unknown, or beyond the utmost limit of Wedgwood's pyrometer. In fact, the greatest fire produced by our furnaces scarcely soften, perceptibly, the platina, in grains. At the most extreme degrees of heat we can only agglutinate these grains together, without imparting to them a true or strong adhesion, since they may be separated by hammering. Macquer and Baume kept several in a continued line, exposed to the constant and violent heat of a glass-house furnace; and these grains only stuck slightly to each other, for they were afterwards separated by the hand. They perceived their color became very brilliant, when they were at a white heat. On exposing the same grains of platina, well purified, to the focus of the burning lens of the Academy, the portions placed in the centre of the focus smoked, melted at the end of a minute, and formed an homogeneous button, white and brilliant, very ductile, and capable of being cut with a knife. Guyton likewise succeeded in fusing small portions in a crucible, by the help of his reducing flux, composed of eight parts of pounded glass, one of calcined borax, and half a part of charcoal, and employing for this operation Macquer's wind furnace. Lavoisier also fused small portions of platina in a cavity on charcoal with a blast of oxygen gas. After all these trials, there is nothing more easy than to procure little buttons of this metal, thus melted; but they are in such small masses that it is impossible to employ them in decisive experiments, and we may still say that

no real and useful fusion of platina has been obtained; since, when treated by the ordinary means, it is impossible to fuse it in such a quantity as allow us to examine its properties, and employ it in experiments capable of rendering us acquainted with them. Accordingly it will appear farther on, that, to apply it to the uses already made of it, the fabrication of plates, bars, wires, vessels, &c. it has been necessary to fuse it by the help of some alloys, and separate it afterwards by forging from the metals united with it.

Platina is a very good conductor of the electric fluid and galvanism. Its power in this respect has not been compared with that of other metals, but it appears to be very great. It has neither smell nor taste, in which it resembles silver and gold.

Platina has hitherto been found no where except in the gold mines of America, particularly in that of Santa Fe, near Carthagena, and in the bailiwick of Choco, in Peru. It is collected in the form of little grains, of a livid gray or white, the color of which partakes of those of silver and iron. These grains are mixed with several foreign substances; among them are found gold dust, blackish ferruginous sand, grains that appear through the lens scorified like the slag of iron, and some particles of mercury.

On examining the grains of platina with a lens, some appear angular, and others rounded or flattened like some pebbles. They may be flattened under the hammer, but some fly to pieces, and these frequently appear hollow within, and contain portions of iron and a white powder. To these small grains of iron must be ascribed the property of being attracted by the magnet, observed in the grains of platina, though well separated from the ferruginous sand among them. To obtain the purest and largest grains of platina, they are sorted by hand, and the gold dust, quartz, sand, and iron, are separated from them.

It is probable that platina is not found in the earth as it is brought to us, and as it is seen in mineralogical collections. The form of grains which it exhibits is owing either to the motion of the water by which it is carried down from the mountains into the plains, or to the grinding of the mills, through which the ores of gold with which it is mingled in the native state are passed. Sometimes pretty large pieces of it have been found. No naturalist has yet described the situations or varieties of ores of platina. It is at present the least known of all metals, and perhaps the only one which, being found hitherto only in one state, has been likewise discovered but in one single country. Platina is very distinguishable by its form, color, and specific gravity. As it is always mixed with sand and iron, and frequently with gold and quicksilver, beside the sorting by hand already mentioned, by means of which Tillet found some grains of this metal embedded in a quartz gangue, different processes are employed for its purification. It is heated red hot to volatilize the portion of mercury left by the amalgamation, by means of which gold was obtained from it. Iron is separated from it by the magnet, which frequently takes up with this attractable metal little fragments of platina. The grains are also heated with muriatic acid, which dissolves and takes up the iron. Bergman has remarked that platina loses 0·05 of its weight by this operation. After this nothing remains but the platina and the gold, both of which are to be dissolved in nitro-muriatic acid; and the proportions of the two metals may be found by precipitating the gold by sulphate of iron, and carefully weighing the precipitate, which, as we have before observed, is in a metallic powder.

As to operations in the great way, there is no one yet settled or practised. The Spanish government, having found that its miners debased gold with platina, and that it was difficult to discover the fraud on account of the specific gravity and unalterableness of this compound, is said to have shut up the mines of platina; but this is an improper expression, which requires to be explained so as to leave no ambiguity or uncertainty. It appears that platina, being always found mixed with gold ore, and both being disseminated in the native state in the same gangue, it is impossible that the mines of platina can have been shut; but as fast as this metal, which does not dissolve like gold in quicksilver, is extracted and separated, it is thrown away, or set apart, so that it is no longer met with in trade as formerly. Hence it is, that the mode of treating it in the large way has made no progress, and that no work in this new branch of metallurgy has hitherto been erected.

Accordingly, what belongs to the metallurgy of platina is nothing more than a series of operations on a larger scale than those of a simple assay, though on a much less than the usual metallurgic operations. It is by these that Carrochez, Jeannety, Chabanon, Wollaston, and several others, have accomplished the fusion, particularly by the help of arsenious acid, or what is called white arsenic, of some considerable quantities of platina; they have hammered and forged it by repeatedly heating and soften-

ing it, so as to deprive it by little and little, and at length completely, of the arsenic which rendered it fusible, and preserved its continuous and connected form, so as to admit of its being flattened, fashioned on moulds, and drawn into wire. It is by a similar operation that it has been brought to the greatest purity, reduced to the common state of other metals, and made to assume forms which may render it useful for various purposes.

As the different processes employed by most of the artists above mentioned for purifying, fusing, and forging platina, have not yet been described, we shall here state one of the simplest which has yet been employed. Dissolve the grains in diluted nitro-muriatic acid with as little heat as possible. Decant the solution from the black matter which resists the action of the acid. Drop into it a solution of *sal ammoniac*. An orange yellow colored precipitate falls to the bottom. Wash this precipitate; and when dry, expose it to a heat slowly raised to redness in a porcelain crucible. The powder which remains is platinum nearly pure. By re-dissolving it in nitro-muriatic acid, and repeating the whole process, it may be made still purer. When these grains are wrapped up in a thin plate of platinum, heated to redness, and cautiously hammered, they unite, and the whole may be formed into an ingot.

It cannot be combined with oxygen, and converted into an oxide, by the strongest artificial heat of our furnaces. Platinum, indeed, in the state in which it is brought from America, may be partially oxidized by exposure to a violent heat, as numerous experiments have proved; but in that state it is not pure, but combined with a quantity of iron. It cannot be doubted, however, that if we could subject it to a sufficient heat, platinum would burn, and be oxidized like other metals: for, when Van Marum exposed a wire of platinum to the action of his powerful electrical machine, it burnt with a faint white flame, and was dissipated into a species of dust, which proved to be the oxide of platinum. By putting a platinum wire into the flame produced by the combustion of hydrogen gas mixed with oxygen, he caused it to burn with all the brilliancy of iron wire, and to emit sparks in abundance.

To obtain the oxides of this metal, it is necessary to have recourse to the action of an acid. When the deep brown solution of platinum in nitro-muriatic acid is treated with lime water, a yellowish brown powder falls. Dissolve this powder in nitric acid; evaporate to dryness, and apply a heat sufficient to drive off the acid. The brown powder which remains is the peroxide of platinum. It is tasteless and insoluble in water. When heated to redness, the oxygen is driven off, and the oxide reduced to the metallic state. One hundred and fifteen parts of oxide, by this treatment, leave 100 parts of metal.

If the heat in this experiment be very cautiously raised, the oxide, before it is reduced, assumes a green color. This change is occasioned by the separation of a portion of the oxygen. The green colored powder is, according to Chenevix, a protoxide of platinum.

The action of the simple combustibles on this metal is not more remarkable than their action on gold.

Neither hydrogen nor carbon have been hitherto combined with it.

Phosphorus unites with it easily, and forms a *phosphuret*. By mixing together an ounce of platinum, an ounce of phosphoric glass, and a drachm of powdered charcoal, and applying a heat of about 32° Wedgewood, Mr. Pelletier formed a *phosphuret* weighing more than an ounce. It was partly in the form of a button, and partly in cubic crystals. It was covered above by a blackish glass. It was of a silver white color, very brittle, and hard enough to strike fire with steel. When exposed to a fire strong enough to melt it, the phosphorus was disengaged, and burnt on the surface. He found, also, that when phosphorus was projected on red hot platinum, the metal instantly fused and formed a phosphuret. As heat expels the phosphorus, Mr. Pelletier has proposed this as an easy method of purifying platinum.

Platinum cannot be made to unite to sulphur by heating them together. In this respect it resembles gold; yet there seems to be an affinity between the two substances, for when the metal is heated with a mixture of potash and sulphur, it is corroded and rendered partly soluble in water, as was proved by the experiments of Lewis and Margarf. And when sulphuretted hydrogen gas is passed into a solution of platinum in an acid, the metal is thrown down in dark brown flakes, apparently in combination with sulphur. Indeed, if we believe Mr. Proust, a sulphuret of this metal occurs sometimes mixed with native platina.

Platinum, as far as is known, does not combine with the simple incombustibles.

It combines with most of the metals, and forms alloys, which were first examined by Dr. Lewis.

Dr. Lewis found that gold united with

platinum when they were melted together in a strong heat. He employed only crude platina; but Vauquelin, Hatchett, and Klaproth, have since examined the properties of the alloy of pure platinum and gold. To form the alloy, it is necessary to fuse the metals with a strong heat, otherwise the platinum is only dispersed through the gold. When gold is alloyed with this metal, its color is remarkably injured: the alloy having the appearance of bell metal, or rather of tarnished silver. Dr. Lewis found that, when the platinum amounted only to one-sixth, the alloy had nothing of the color of gold; even one-forty-second part of platinum greatly injured the color of the gold. The alloy formed by Mr. Hatchett of nearly eleven parts of gold to one of platinum, had the color of tarnished silver. It was very ductile and elastic. From Klaproth we learn, that if the platinum exceed one-seventeenth of the gold, the color of the alloy is much paler than gold; but if it be under one-seventeenth, the color of the gold is not sensibly altered. Neither is there any alteration in the ductility of the gold. Platinum may be alloyed with a considerable proportion of gold, without sensibly altering its color. Thus an alloy of one part of platinum with four parts of gold can scarcely be distinguished in appearance from pure platinum. The color of gold does not become predominant till it constitutes eight-ninths of the alloy.

From these facts it follows, that gold cannot be alloyed with one-tenth of its weight of platinum, without easily detecting the fraud by the debasement of the color; and Vauquelin has shown, that when the platinum does not exceed one-tenth, it may be completely separated from gold by rolling out the alloy into thin plates, and digesting it in nitric acid. The platinum is taken up by the acid, while the gold remains. But if the quantity of platinum exceeds one-thirtieth, it cannot be separated completely by that method.

Some trinkets and utensils for the table have already been made of platina; but though they have the advantage of being unalterable and infusible, they have the real defect of not possessing a fine color, and are at the same time very ponderous. Platina, therefore, can be employed only for small and slender instruments, capable of being exposed to several corrosive matters, and to the air, without being altered by them; but this use is confined within narrow bounds.

By mixing it with copper and arsenic, in various proportions, mirrors for telescopes have been fabricated of it, which will never experience any alteration in their polish, and which unite with a bright and perfectly uniform polish of surface, a complete incapability of being altered by any possible agent.

Platina also promises the greatest and most important advantages in mechanics, and particularly in the delicate art of making time-pieces. The construction of a great number of machines will gain by the acquisition of this metal, which may be substituted in numerous cases for copper, iron, and even silver.

History of Astronomy—its various Systems.

[Continued from Vol. II, page 190.]

The Solar System.—The Solar, or true system of the world, as already observed, was taught by Pythagoras; but afterwards lost till the time of Copernicus, who again revived it, and from this circumstance it is often called the Copernican System.*

In this system, the Sun is placed nearly in the centre of the orbits of all the planets and comets; and in these orbits they perform their revolutions round the Sun in their respective periodic times. The number of planets at present known to belong to the solar system is 29, of which 11 are Primary, and 18 Secondary.

The Primary planets are those that circulate round the Sun as their centre, viz. Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus or Georgium Sidus, Ceres, Pallas, Juno, and Vesta. See the figure on the following page.†

The first six were known to the ancients, and are therefore called the *old* planets. The last five have been discovered since the year 1781, and are often called the *new* planets.

Those planets that have their orbits included within the Earth's orbit, are called *Inferior*, and those without the orbit of the Earth are called *Superior* planets.

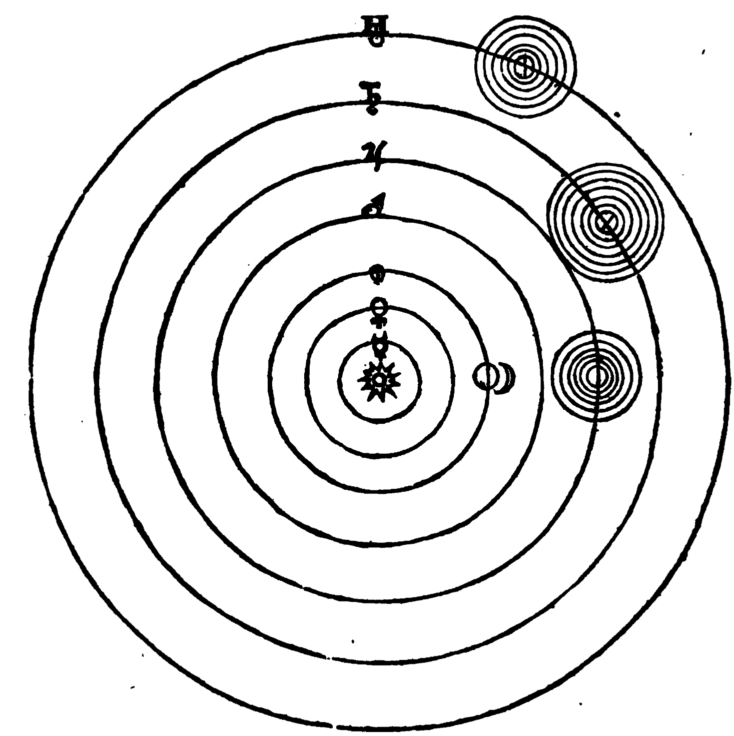
The Moon is a secondary belonging to the Earth, and circulates round it while the Earth continues its annual course round the Sun. Jupiter has four secondaries or satellites revolving round him; Saturn has seven; and Uranus has six.

The orbits or paths in which the Primary Planets perform their revolutions round the

---

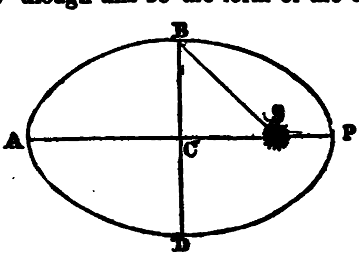
* From the labors of Sir Isaac Newton to establish the system of Copernicus, it is sometimes called the *Newtonian* system.

† This figure represents the order in which these planets move round the Sun; but the circles, which represent the respective orbits, do not show the proportional distance of each planet from the Sun. To do this accurately would require a very large figure.



Sun, and the Secondaries round their Primaries, are not exactly circles, but Ellipses or Ovals.*

Now though this be the form of the orbit



which the planet describes, yet the place of the Sun is not in the centre of the orbit, but in one of the Foci, as at S.

When the planet is at P, it is then nearest the Sun, and is said to be in its Perihelion. In moving from P, its distance from the Sun gradually increases till it reaches the opposite point A, when it is at its greatest distance from the Sun, and is then said to be in its Aphelion. When it arrives at the points B and D, it is said to be at its Mean Distance. The straight line A P, which joins the perihelion and aphelion, is called the line of the Apsides, and sometimes the greater axis or the transverse axis of the orbit. The line B D, joining the points of *mean* distance, is called the conjugate or lesser axis: S B or S D, the planet's mean distance from the Sun; S C or F C, the eccentricity of the orbit, or the distance of the Sun from its centre; S the lower Focus, or that in which the Sun is placed; F the higher Focus; P the *lower Apsis*, and A the *higher Apsis*. Though the Primary Planets have all nearly the same common focus in which the Sun is situated, yet they have not all the same degree of ellipticity. Most of them deviate but little from the circular form, and none of them so much as the last figure. The orbits of the different planets do not all lie in the same plane, as they appear to do, when represented on paper.

If the Earth's orbit be supposed to be a thin solid plane, and to be extended in every direction, it will mark out a line in the starry heavens, which is called the *Ecliptic*, and the plane itself is called the *Plane of the Ecliptic*. The orbits of all the other planets

* If the two ends of a thread be tied together and thrown loosely over two pins stuck in a table, as S and F, (figure above,) and if the thread be moderately stretched by the point of a pen or black lead pencil, and carried round the pins by an even motion and slight pressure of the hand, an ellipse or oval will be described; the points A and P, where the pins were fixed, are called the foci, or focuses of the ellipse. The figure described will be the more elliptical the tighter the thread is to the pins in the foci.

lie in planes different from this plane; but the one half of each orbit rises above it, and the other falls below it,* consequently the orbit of each planet crosses the ecliptic in two opposite points, which are called the planet's *Nodes*. These nodes are all in different parts of the Ecliptic, and therefore if the planetary tracks remained visible in the heavens, they would in some measure resemble the different ruts of waggon wheels crossing each other in various parts, but never going far asunder. That *node* or intersection where the orbit ascends above the ecliptic is called the *ascending node*, and the other, which is directly opposite to it, is called the *descending node*.

While the primary planets are performing their revolutions round the Sun, and the secondaries round their primary planets, they have all a motion from west to east round an imaginary line passing through their centres, called their axes. The axis of some of the planets is much more inclined to the axis of its orbit than others, and on this depends the change of seasons in the planet;† for the more the axis of any planet is inclined to the axis of its orbit, the greater will be the variety of its seasons.‡ The extremities of the axis of any planet are called its Poles. That which points towards the northern part of the heavens is called the North Pole, and the other pointing towards the southern part is called the South Pole.

As the Earth turns round its axis in 24 hours, the heavens will appear to make a complete revolution in that time: and to a spectator on any of the other planets, this revolution will seem to be performed in the time which this planet takes to perform a revolution on its axis, which is called the length of the planet's day.

As it is necessary to have some method by which the position of any celestial body may be determined at any time, or its distance from some known point, astronomers have fixed on the Ecliptic or Earth's orbit for this purpose, as well as for reckoning from it the inclination of the planetary orbits. The line of the Equinoxes, or that line in which the Earth's equator, when extended to the heavens, cuts the Ecliptic (being always in the plane of the Ecliptic) must mark out two points of that line traced among the stars; and from one of these points astronomers reckon the distances on the ecliptic. This point is called the *vernal* Equinox, because the Sun appears in it about the middle of Spring or the 20th of March; its opposite is called the *autumnal* Equinox, the Sun being in it about the middle of Autumn, or the 23d of September.

The Ecliptic is supposed to be divided into twelve equal parts, called signs, of 30 degrees each. Their names and characters are the following:

♈ Aries,	♎ Libra,
♉ Taurus,	♏ Scorpio,
♊ Gemini,	♐ Saggittarius,
♋ Cancer,	♑ Capricornus,
♌ Leo,	♒ Aquarius,
♍ Virgo,	♓ Pisces.

The *Longitude* of all the heavenly bodies is reckoned eastward on the ecliptic from the vernal equinox (where the sign Aries begins) quite round the heavens.

The *Latitude* of any celestial body is reckoned from the ecliptic, north and south; but its declination is counted from the equinoctial, in a similar manner.

The *Right Ascension* of any celestial body is reckoned on the *equinoctial* from the vernal equinox, or the first point of Aries, eastward quite round the heavens.

Instead of the vernal equinox, astronomers sometimes find it convenient to count the distance of a planet from its aphelion. This distance is called the true anomaly of the planet.

Of the Sun.—The Sun is the largest body yet known in the universe. His diameter is 887,693 English miles; his circumference 2,800,000; and his bulk is above 1,400,000 times greater than the Earth. Although the Sun be the fixed centre of the universe, he has been discovered to have a motion round his axis in 25 days 10 hours, and another round the centre of gravity of the planetary motions. The motion round his axis was discovered by Galileo in the year 1611.

When the Sun is examined with a telescope of a tolerable magnifying power, and a piece of dark glass interposed to prevent his rays from hurting the eye, a number of dark spots, of various forms and magnitudes, are frequently perceived on his disc. These spots are sometimes so very large as to be perceptible with the naked eye. The nature and formation of the solar spots have been the subject of much speculation and conjecture.

* The angle which each orbit makes with the plane of the ecliptic is called the inclination of the orbit. The orbit of Mercury is inclined 7° to the plane of the ecliptic; Venus, 3° 23′; Mars, 1° 51″; Jupiter, 1° 19″; Saturn, 2° 30′; Uranus, 0° 46½′; Ceres, 10° 37′; Pallas, 34° 50′; Juno, 21°; and Vesta, 7° 9′. The orbits of all the *old* planets are included in the Zodiac, which is a belt or zone in the Heavens, extending about 8° on each side of the ecliptic: but the orbits of the *new* planets are without the zodiac.

† The axis of the earth is inclined 23° 28′ to the axis of its orbit, which is the cause of the different lengths of the days, and variety of the seasons.

‡ The axis of the orbit of any planet is a straight line, perpendicular or at right angles to the orbit.

Some astronomers have affirmed that the Sun is an opaque body, mountainous and uneven like the Earth, and covered all over with a fiery and luminous fluid: that this fluid ebbs and flows after the manner of our tides, so as sometimes to leave uncovered the tops of rocks or hills, which appear like black spots, and that the nebulosities about them are caused by a kind of froth. Others have imagined that the fluid which sends us so much light and heat contains a nucleus or solid globe, wherein are several volcanoes, which, like Ætna or Vesuvius, from time to time, cast up quantities of bituminous matter to the surface of the Sun, and form those spots that are perceptible on his disc; and that this matter is gradually consumed by the luminous fluid, and then the spots disappear for a time, but are seen to rise again in the same places when those volcanoes cast up new matter. A third opinion is that the Sun consists of a fiery luminous fluid, wherein are immersed several opaque bodies of irregular shapes; and that these bodies, by the rapid motion of the Sun, are sometimes buoyed or raised up to the surface, where they form the appearance of spots, which seem to change their shapes according as different sides of them are exposed to our view. A fourth opinion is, that the Sun consists of a fluid in continual agitation; that, by the rapid motion of this fluid, some parts, more gross than the rest, are carried up to the surface of the luminary, like the scum of melted metal rising up to the top in a furnace; and that these scums, as they are differently agitated by the motion of the fluid, form themselves into those spots that are visible on the solar disc.

Dr. Herschel supposes the Sun an opaque body like the planets, surrounded by an atmosphere of a phosphoric nature, with a number of luminous clouds floating on it; and that the dark nucleus of the spots are occasioned by the opaque body of the Sun appearing through openings in his atmosphere.

The late Dr. Wilson, of Glasgow, has advanced a new opinion respecting the solar spots. He supposes, with great appearance of truth, that they are depressions rather than elevations; and that the dark nucleus of every spot is the opaque body of the Sun seen through an opening in the luminous atmosphere with which he is surrounded.

Amidst all these conjectures, we are still left in uncertainty: for there appears little in any of them to entitle it to a superiority over the other. In one particular they all agree: namely, that the Sun is either composed of, or surrounded by, some very powerful heating substance; but what that substance is, or how it is maintained, they are all at a loss to determine. Many experiments have been made, both in this country and on the continent, to determine the heat of the Sun, or the *intensity* of his rays, when concentrated in the focus of a lens, or by reflecting mirrors. Among these may be mentioned the experiments made by Dr. Harris and Dr. Desaguliers, with a mirror constructed by Mr. Vilette. It was 3 feet 11 inches in diameter, and its focal distance was 3 feet 2 inches. A fossil shell was calcined by it in 7 seconds; copper ore vitrified in 8 seconds; iron ore melted in 24 seconds; talc began to calcine in 40 seconds; a great fish's tooth melted in 32½ seconds; a silver sixpence melted in 7½ seconds; a copper halfpenny melted in 20 seconds; tin melted in 3 seconds; cast iron in 16 seconds; slate melted in 3 seconds; bone was calcined in 4 seconds. So powerful are the Sun's rays when condensed by burning glasses, that it is said Archimedes set fire to the Roman fleet at the siege of Syracuse by a combination of these glasses; and Buffon, in the year 1747, constructed a reflecting mirror of 168 plane glasses, moveable on hinges, with which he set wood on fire at the distance of 150 feet, and melted lead at 145 feet.

On Magnets. By Geo. Clark. To the Editor of the Mechanics' Magazine.

Sir,—Having seen in a London periodical (the Lancet) an account of the wonderful cures at St. Bartholomew's Hospital, by Drs. Kyle and Blundell's newly discovered powerful magnets, I have been induced to make one from a model furnished me by a gentleman well acquainted with them. It has been tried by a medical gentleman in this city, on a lady much afflicted with rheumatic pains, and the success exceeded his most sanguine expectation. The magnet attracts the pain from the various parts of the body to the extremities; and from thence draws the pain away. I make this communication through your valuable magazine in hopes that others of the faculty may prove by experiments the great utility of this most interesting discovery, and thereby remove any doubt that may be entertained on the subject.

I am, sir, your obedient servant,

Geo. Clark,

136 Spring street, New-York.

January 7, 1834.

New Plaster Bed.—An inexhaustible bed of superior gypsum or plaster has been discovered on the Cascadilla, near the village of Ithaca, and proves equal to that from Nova Scotia.

INTRODUCTORY ADDRESS

Delivered before the Mechanics' Institute of the City of New-York, November 27, 1833,

by Gulian C. Verplanck.

Several years ago, in conversation with a very ingenious and well-informed friend, now deceased, I was much struck by a transient observation of his. "In spite," said he, "of man's boasted intellect, he is as much indebted for his present state in civilized life, to the hand as to the head. Suppose," proceeded he, "that the human arm had terminated in a hoof or a claw, instead of a hand, what would have been the present state of society, and how far would mere intellect have carried us?"

I do not know whether this idea was original with my friend or not, although I have never since heard it or met with it in books; and as he did not follow it out any further, I cannot say what were the particular consequences he meant to infer from it. Let us for a moment take up the supposition and follow it out for ourselves. Let us suppose that all the other original as well as secondary causes, which have operated upon the human race, to bring civilized society to its present state of art, power, knowledge, refinement, and wide-spread comfort and luxury, to have remained as nearly as possible the same. Let us imagine the reason of man to have been as powerful, his curiosity as active, his talent, courage, energy, enterprize, equal, nay, if you will, superior to that which he now possesses and exerts. But in place of his hand, that exquisite and wonderful piece of mechanism, so beautiful in its contrivance, so perfect in its construction, so infinite in its uses, obeying the mind's impulse with an accuracy and rapidity which the mind itself cannot comprehend or follow—in place of that he has the paw of a wild beast. Under such circumstances, unquestionably, some form of society, of government, and of social order, might exist. The human mind might slowly observe and compare many of the truths of reason and the laws of nature. The first principles of mathematics, depending as they do upon pure reason, might possibly have been discovered, and the science of numbers and figure and measure developed in theory by individuals, to no inconsiderable extent. In a race of men so formed, there might possibly be poets and orators, whose fancy or eloquence might have rivalled or resembled those of the great names of the world's early history. There might, and there doubtless would, have been the frequent exertion of brute valor; and there probably would have been sometimes added that application of mind to courage, which makes of the soldier a hero, a leader, a conqueror.

But here the force of mere mind, in such a world as ours, must have stopped. Without the mechanical assistance of the hand, most of the discoveries and improvements of each generation must have died with them, and left no preparatory stock of knowledge to the next, for the want of the art of writing. But this, however great it may seem in itself, is but the most inconsiderable of the privations to which man would be subject. "Man," says Franklin, "is a tool-making animal," and without the hand, where would be the tools of agriculture—the plough, the spade, and the waggon? where the builder's skill, and the houses which now shelter happy families, in place of the cave and the forest? where the boat, the sail, the ship, which connect nations together, and make the wealth and the wisdom of each portion of our race in some degree the property of all? As we proceed in this analysis, we may thus trace back the comfort, the happiness, the safety, the splendor, nay, the very affections and virtues of social and civilized life, to the industry of the hand. Still, all this is the fruit of the labor of the hand guided by intelligence. It is the toil of the hand directed by experience, strengthened by knowledge gained by the past experiment, by the observation of nature, and by the application of reason to that experience and observation. This it is that constitutes that enlightened labor to which society owes its elevation and its happiness. This it was that

——"roused man from his miserable sloth,
His faculties unfolded, pointed out
Where lavish Nature the directing hand
Of art demanded, showed him how to raise
His feeble force by the mechanic powers,
To dig the mineral from the vaulted earth,
On what to turn the piercing rage of fire,
On what the torrent and the gathered blast
Gave the tall, ancient forest to his axe,
Taught him to chip the wood and hew the stone,

Till by degrees the finished fabric rose;
Tore from his limbs the blood polluted fur,
And wrapt him in the woolly vestment warm;
Nor stopped at barren, bare necessity,
But still advancing bolder led him on,
To pomp, to pleasure, elegance, and grace,
And breathing high ambition in his soul,
Let science, wisdom, glory, in his view,
And bade him be the lord of all below."*

Such, in the language, but without the exaggeration of poetry, are the magnificent results of intelligent industry, of the hand executing what the mind has devised or discovered; either of them without the other being powerless, to any greatly useful end. The mind without the hand must be compelled to waste its force upon barren speculation, or to amuse itself with the fleeting visions of fancy. The hand without the guiding mind is bloody and dangerous, quick to injury, slow and awkward in any work of peace. Let them act together in intelligent unison, and then the whole man and the whole frame of society will move together in cheerful activity, right onwards to their highest possible perfection and happiness. It is the boast of our own country and times, and civil condition, that they are all auspicious to this union and the attainment of these ends. To co-operate to the best of his ability in securing and hastening forward this excellent and beneficent effect, and especially to make its blessings more immediately felt by those around and about him, is at once the duty of every good citizen and his most exalted privilege.

It is with such motives and views that you, fellow-citizens, have founded the MECHANICS' INSTITUTE OF THE CITY OF NEW-YORK. Its primary object you have stated, in your constitution, to be "the instruction of mechanics and others in popular and useful science, and its application to the arts and manufactures, by means of lectures, apparatus, models of machinery, a museum, and library."

In discharging the grateful and honorable duty which you have confided to me, of opening the course of scientific lectures arranged for the present season, perhaps I cannot better employ the limits of an introductory lecture, too circumscribed for the particular elucidation of any single prominent branch of scientific inquiry, than by considering a few of the more important advantages which may justly be expected to flow from instruction of the kind proposed by your institution.

Let me invite your attention, first, to the consideration of the probable beneficial effect of the diffusion of scientific knowledge, amongst those practically and habitually employed in the mechanic and manufacturing arts, as it is likely to operate upon the improvement and advancement of the arts and sciences themselves. This is a view of the subject which probably did not occupy the foreground in the minds of the founders of the Institute; but I place it first, because it first occurred to my own thoughts, and because, too, if not the very first in importance among the many uses of such institutions as this, it is scarcely secondary to any other.

Perhaps there is no better definition of Science, than that it is knowledge acquired by the thoughts and the experience of many, and so methodically arranged as to be comprehended by any one. That which exhibits the truth, reasoned out by the mind from its own intuitive perceptions, and which relates not merely to that which is, but to that which *must* be, (such as the deductions of mathematics,) constitutes abstract science.

Physical science is the methodized and therefore simplified knowledge of the order of nature, so far as hitherto observed. This consists mainly in the classification, under general rules and names, of multitudes of observations and experiments. It arranges and generalizes the observations of all ages, made by those who, with eager eyes and attentive minds, have read the great book of Nature, which she opens of her own accord to all men, and the experiments, that by new and bold combinations of agents, or powers that do not ordinarily appear together, have questioned Nature herself, and forced her to reveal the secret rules and methods of her mighty operations. It is the business of the true teacher of useful science to lay all this before his pupils, clearly, briefly, and methodically, thus following out and applying that beautiful and benevolent fundamental law of the Author of all being and of all wisdom, who, governing all things by vast and comprehensive rules, includes millions of apparently jarring phenomena under the operation of some single cause, and has thus made a kind provision whereby the limited mind of man may grasp and turn to its own uses the laws that sway the whole creation.

The theory of science, then, is the exposition of known facts, arranged in classes and

* Thomson.

expressed in words. Let then this general and preparatory acquaintance with the ascertained laws of nature be widely spread amongst those who are constantly and habitually engaged in the various operations of the useful arts, and what will be the probable consequence? Instead of a comparatively few observers, most of whom see nature "through the spectacles of books," or at best on the limited scale of the laboratory or the lecture room, we have at once hundreds of men well grounded in the principles of chemistry, mechanics, and general physical science, perpetually observing, watching, comparing, applying, the working of those principles on the largest scale, and under some peculiar advantages, which the man of mere speculative science can rarely enjoy. For instance, all who have ever turned their attention to mechanical invention know how often and how signally the most ingenious conceptions, succeeding admirably in the model, are frustrated and found worthless when applied to practice on the scale necessary for any useful purpose. However valuable the model may be as an auxiliary, nothing but actual experience can teach the operation of friction, of gravity, of the nature of materials, of the varying proportion of weight and strength in relation to an increased scale of size, and numerous other circumstances which would require a lecture to detail.* But the knowledge of all this is precisely what constitutes the difference between the accomplished speculative projector and the successful practical machinist; and as all this is every hour before the eyes of the actual mechanic, it surely must prove a great thing for the improvement of mechanical skill and invention, to have this observation assisted and enlightened by sound theory, or, in other words, by a clear and distinct apprehension of what has already been invented or discovered.

In visiting our national patent office, and conversing with the officers of the establishment, it becomes a common subject of remark, how prodigious a waste of ingenuity, in various ways, and particularly in mechanical contrivance, takes place annually in this country, for the want of a more general knowledge of the actual state of improvement in the several departments of invention. Hundreds of useful or ingenious machines have been thus re-invented, doubtless with no little loss of that intellectual labor, which, if it had been applied in improving or building upon what was already known, might have opened to society new sources of comfort, of pleasure, or of power.

The advantages of experience and observation on a large scale, are, by no means, peculiar to mechanical ingenuity. Indeed, I meant to draw from it simply an example or illustration of a truth common to all the mechanic and manufacturing arts. It is peculiarly true with regard to the chemistry of the arts. It has been remarked by the most successful chemists of our day, that some of the most important manifestations of the laws of chemical action could hardly have been discovered in the course of any of the experiments of the chemical laboratory, however skilful or costly. In order to manifest themselves to observation, they require the action of large masses or quantities together, perhaps that of the elements upon them, or of a considerable lapse of time. In fact, the very foundation of modern chemistry, or at least of that branch of it termed Pneumatic Chemistry, was laid in a brewery. There had been no lack of ingenuity, no sparing of labor or expense, no flagging of zeal or curiosity among the old chemists. But the larger and more striking field of observation and combination afforded to Dr. Priestley, by the vats and gases of his neighbor the brewer, opened a new world to inquiry. From the thick vapors of the brew-house, like one of the gigantic genii of Arabian romance, arose that mighty science which has given to enlightened art a more than magical sway, enabling her to clothe her productions with vivid beauty, to dispense amongst all those fabrics which were once reserved for kings and princes, to chase away disease, and to arm man with a strength such as ancient poets never dreamt of in their wildest tales of heroes, giants, and demi-gods.

Will it not, then, promise much for the still further and more rapid advancement of knowledge and art, if all those immense processes, combinations, unions, affinities, conversions, formations, decompositions, which are incessantly going on in the brewery, the dye-house, the distillery, the manufactory of drugs, paints, metals, glass, porcelain—in short, in all the establishments of refined and ingenious art; I say, to have all these watched, tested, analyzed, applied, separated from whatever may impede their action, or united to whatever may add to it—and this done by men skilled in their particular vocations, and, moreover, able to call in the aid of science to explain difficulties or direct observation?

It is wonderful how the elements of the most precious knowledge are spread around us

---

* See them well explained in an ingenious paper, by Mr. Sang, "on the relation between a machine and its model," printed in Silliman's Journal, Vol. xxii. No. 2; also, in this Magazine. Vol. i. No. 6, p. 302.

—how to the curious and instructed observer every thing is full and rich with the means of benefitting the human race. The slightest accession to our knowledge of nature, or our command over it, is sure ultimately to connect itself with some other truth, or to unfold its own powers or relations, and thus to lead on to some practical benefit, which the boldest conjecture could never have anticipated. The ignorant and the idle suffer all such opportunities to pass by them as the vagrant breeze. But such will surely not be the case with industrious men, prepared by general science (as it is the object of this institution to prepare them) to turn those occasions to the best account. In so saying, I do not speak from hope or conjecture, or theory, or the desire of stimulating your zeal by flattering words. I argue from experience. I draw my anticipation of what may be, from the actual history of what has been. Let me give you the evidence of this by some few examples selected out of many hundreds. Take for instance the history of one of the most recent and precious gifts which chemistry has made to medicine.

A few years ago a soap manufacturer of Paris, M. Courtois, remarked that the residuum of his ley, when exhausted of the alkali, produced a corrosion of his copper boilers, which struck him as deserving special inquiry. "He put it," says Mr. Herschell, "into the hands of a scientific chemist for analysis, and the result was the discovery of one of the most singular and important chemical elements, *iodine*. The properties of this, being studied, were found to occur most appositely in illustration and support of a variety of new, curious, and instructive views then gaining ground in chemistry, and thus exercised a marked influence over the whole body of that science. Curiosity was excited; the origin of the new substance was traced to the sea plants, from whose ashes the principal ingredient of soap is obtained, and ultimately to the sea-water itself. It was thence hunted through nature, discovered in salt mines and springs, and pursued into all bodies which have a marine origin; among the rest into sponge. A medical practitioner (Dr. Coindet, a Swiss physician,) then called to mind a reputed remedy for the cure of one of the most grievous and unsightly disorders to which the human species is subject—the *goitre*,—which infests the inhabitants of mountainous districts to an extent which, in this favored land, we have happily no experience of, and which was said to have been cured by the ashes of burnt sponge. Led by this indication, he tried the effect of iodine on that complaint, and the result established the extraordinary fact, that this singular substance, taken as a medicine, acts with the utmost promptitude and energy on goitre, dissipating the largest and most inveterate in a short time, and acting (of course with occasional failures, like all other medicines,) as a specific or natural antagonist against that odious deformity."

Now, consider what a mass of human misery, for a long series of generations to come, has been relieved or removed by this discovery, arising from the single circumstance of a Parisian soap manufacturer being an observing man, who understood the uses and nature of chemical analysis. How many human beings who would have dragged out a wretched existence, deformed, dejected, and miserable, may now lead healthy and happy lives, in consequence of a discovery depending upon a circumstance which would probably never have fallen under the notice of the learned physician or the mere chemist of the laboratory.*

Let us cross the channel to Great Britain for some further examples, and learn from what has been done there by mechanical, united to scientific skill, what we may reasonably hope to see done among ourselves.

It were idle to waste words in showing how much of the present prosperity, wealth, intelligence, and means of enjoyment, in the civilized world, depends upon the art of navigation—and how much the perfection of that art is connected with the accuracy and advance of astronomy—and, again, how that science depends upon the excellence of its great instrument, the telescope. The telescope, in its earlier stages of invention, had received all the improvement that could then be furnished by the genius of the great Galileo, the father of modern science, and by the super-human philosophical sagacity of Sir Isaac Newton, as well as of their disciples and followers, the most learned and ingenious men of Europe, such as the English Hooke, the Dutch Huygens, and the German Euler.

The product of these labors was indeed an admirable proof of the power of human invention; yet it was accompanied with imperfections, especially in the refracting telescope, that seemed insuperable. Your lecturer, when explaining the doctrines of optics, will state to you, more fully and clearly than can now be done, the nature and cause of this

* The still more recent discovery of Bromine, another elementary chemical substance, by M. Balard, a chemical manufacturer in the south of France, affords a similar example of a valuable accession to science from the observation of the manufacturer.

difficulty. It is sufficient for my present purpose to say, that from the supposed inherent imperfection of the refractive powers of glass, the images seen by the aid of the telescope were formed very indistinct and confused, being tinged strongly with the several prismatic colors. The removal of this defect was reserved for JOHN DOLLOND, originally a silk-weaver, and afterwards an optician and instrument maker, of London. Half a century after Newton's experiments, Dollond conceived the idea that the refractive powers of different kinds of glass might be made to correct each other. In this he completely succeeded, and by the combination of scientific sagacity, with that tact which is the growth of experience alone, at once enriched theoretical philosophy by the discovery of an important optical law, and in his achromatic telescope presented a more perfect and commodious instrument to astronomy. Had he not been familiar with the science of Newton, Dollond would never have attempted this discovery; had he not also been a practical mechanic, it is hardly probable that he would have succeeded.

The incidental mention of the ultimate advantages derived by the art of navigation from the labors of Dollond, suggests to my mind another illustration, and recalls the name of JOHN SMEATON. He was by regular trade a philosophical instrument maker; but his active mind had taken a broad range of rational curiosity and employment, embracing almost every thing in science or art that could throw light on mechanical contrivance. His inventions of this sort were very numerous and ingenious, but his solid fame rests chiefly upon the erection of the Eddystone Lighthouse. Its site was one of the utmost consequence to the naval and commercial marine of Great Britain, and, indeed, of the world. As it was to be placed on a reef of rocks, far from the main land, and exposed to the whole force of the waves of the Atlantic, the building of a durable edifice there had baffled the skill of the ablest architects. At that period, about the middle of the last century, that branch of marine construction which relates to piers, moles, artificial harbors, breakwaters, &c., was far from that scientific developement it has since received, and which it in no small degree owes to Smeaton himself. The commissioners for re-building the lighthouse, aware of the difficulties they had to encounter, reported that this was not an undertaking for a mere architect, however skilful, but required the talent of some one eminent for general mechanical skill and contrivance. Smeaton was selected. His plan was wholly original, having been suggested immediately by the consideration of the means used by nature to give durability to her works, and taking the model of strength and resistance to the elements which she had given in the trunk of the oak.* The execution corresponded with the boldness and perfection of the first conception. There are few narratives of more intense interest or varied instruction than his own account of this great work, which is among my earliest and most vivid recollections of this sort of reading. I will not attempt to mar it by a meagre abstract. It is enough to say that this noble effort of mechanical genius, thus grafted upon and made part of the rocky bottom of the sea, and resisting the immense might of the ocean, which it faces, has never been surpassed or improved upon, but has been the model or guide of numerous subsequent works of marine construction of great excellence and unbounded utility.

The ancient Pharaohs of Egypt, in the pride of conquest or the vain hope of immortality, exhausted the labors of millions of slaves to rear immense pyramids and tall and huge granite obelisks. The imperial Trajan, the most illustrious name of Rome after the loss of her liberties, decorated his forum with that magnificent column which still bears his own name, and upon which the sculptor lavished his art, to commemorate the victories of its founder over the Dacian barbarians, as they were called: that is to say, over a race of free and brave men, who had struggled for their liberties against the grasping tyranny of Rome, with a courage and talent worthy of a better fate. Napoleon, whose sublime genius and grand aspirations were yet unhappily alloyed by so great an admixture of the meaner ambition of ordinary kings and conquerors, reared, in his own capital, the lofty brazen column of his victories, cast from artillery won on the bloody fields of Marengo, and Jenna, and Austerlitz. Upon that vast bronze, the veteran companions of his glories can behold, in bold relief, the storied images of their campaigns, their toils and their exploits, and those of their chief and their hero.

---

* "The building," says one of Smeaton's biographers, "is modelled on the trunk of an oak, which spreads out in a sweeping curve near the roots, so as to give breadth and strength to its base, diminishes as it rises, and then again swells out as it approaches to the bushy head, to give room for the strong insertion of the principal boughs. These boughs are represented by a broad curved solid stone cornice, the effect of which is to throw off the heavy seas, which, when thus suddenly checked, fly up, as is said by eye-witnesses, fifty or a hundred feet above the top of the building, and are thus prevented striking and injuring the lantern containing the lights, though for the moment enclosing it all around."

But, in the eye of sober reason, how poor and how vain are these monuments of pride, of power, of glory, and even of genius, when compared to the solitary sea-girt unadorned Atlantic tower, which perpetuates the name, the talent, and the unambitious labors of John Smeaton! The glories of the conquerors have vanished like the morning mist. Their conquests and their empires have crumbled into dust; but the Eddystone tower stands firm amidst the tempest and the uproar of the ocean; and there, and wherever else its form is imitated or its principles applied, as on our coasts and on the shores of our western lakes, it throws its broad light across the storm and the gloom, giving safety to the mariner, and guiding that commerce which, making the natural riches of every climate the common property of all, is surely destined to bind together the whole family of man in the mutual and willing interchange of art and learning, and science, and morals, and freedom.

I might continue my illustrations from the history of useful science to an extent far beyond the limits that would be proper on this occasion. The names and lives of our own distinguished benefactors of mankind, Franklin and Rittenhouse, and Whitney, and Fulton, and Perkins, press upon my memory. Again, the history of the watch and clock, from their early invention to their present admirable state of perfection in the astronomical clock and the marine chronometer, as successively improved by men educated in the practical art and able to apply the helps of science, would alone afford the materials for a lecture.

The history of printing offers another tempting field of collateral illustration. I might show you how numerous and how precious are the contributions, that have been made by a succession of learned printers, to literature, philosophy, and those principles of tolerance and freedom, which it is the sacred office of the press to perpetuate and diffuse. I might tell of the Italian Aldus and his sons, of Henry Stephens of Paris and his learned family, of the Dutch Elzevirs, the English Bowyer, the Scotch Foulis and Duncan, and surely could not forget the noblest name of them all, our own Franklin. It is from the influence of these men, and such as these, that the printing office has become, to use one of its own phrases, the *Chapel* of Liberty, where is her living presence, and where are reared the altars upon which are daily kindled the clear and bright lights of instruction for the illumination of mankind. There the goddess treasures up her arms, her ægis, and her lightnings. There is she worshipped by an assiduous, an intelligent, an ardent, and a faithful priesthood.

I must also reluctantly refrain from detailing the studies, inventions, and improvements of the potter, Josiah Wedgewood. His chemical and geological acquirements, applied to the experience of his Staffordshire pottery, have filled the houses of all classes with those cheap, cleanly, and elegant luxuries of china and finer earthenware, such as before his days princes alone could purchase; whilst his pure taste and acquaintance with antiquity have imparted to the ordinary productions of the potter's mould and lathe, the grace and beauty of the most costly works of ancient art.

I content myself with barely mentioning these points of illustration, leaving them to be followed out by your own reading or recollection. But from among the names that thus crowd upon me, let me adduce one more bright example, which I select chiefly because it is most intimately and gloriously connected with that application of science to which our own country, and, I may add, our own state and city, are most largely and peculiarly indebted.

It was about this season of the year, just seventy years ago, that the instrument maker, employed by the University of Glasgow, received from the Professor of Natural Philosophy, in that ancient seminary of learning, a broken model of the steam engine as then used, to be put in order for his lectures. It was the simple and very imperfect machine of Newcomen, the best form of the steam engine that had then appeared, and which had been found rather useful as a somewhat economical substitute for the labor of men or horses. But no one had yet viewed the steam engine as the means of a new creation of force, whereby the winds and the waves could be breasted and subdued, the weight of mountains raised, or the most delicate manipulations of the human hand imitated and surpassed. An ordinary workman, after admiring the ingenuity of this imperfect machine, would have made the necessary repairs, sent it back to the lecture room, and the world would have gone on as usual. But it had fallen into the hands of James Watt, a young mechanic, of singular and various inventive sagacity, and of most patient and persevering ingenuity, who, in addition to much miscellaneous information and some mathematical acquirement, had been led by a liberal curiosity to master all that was then known of chemistry and theoretical natural philosophy in its broadest sense. He was struck with the latent capabilities of the agent used in the imperfect engine before him; and to develope these powers, he applied his mind, he tasked his invention, he called in the aid of all collateral science. The mode

and extent of his success have doubtless been heretofore explained to those of you not practically acquainted with the subject, and will I presume again form a part of this winter's course of instruction. I invite you now only to consider what was achieved by the labors of Watt. He was not merely the improver of the steam engine, but in fact, as to all that is admirable in its structure or vast in its utility, he has the clear right of being honored as its inventor. "It was by his invention," says an eloquent eulogist of his character and genius,* "that its action was so regulated as to make it capable of being applied to the finest and most delicate manufactures, and its power so increased as to set weight and solidity at defiance. By his admirable contrivances, it has become a thing stupendous alike for its force and its flexibility; for the prodigious power that it can exert, and the ease, precision, and ductility, with which it can be varied, distributed, and applied. The trunk of an elephant, which can pick up a pin or rend an oak, is as nothing to it. It can engrave a seal, or crush masses of obdurate metal like wax before it—draw out without breaking a thread as fine as gossamer, and lift a ship of the line, like a bauble, into the air. It can embroider muslin and forge anchors—cut steel into ribbons, and impel loaded vessels against the winds and waves."

But look around for yourselves—on our rivers and lakes—on the manufactures of Europe and America, piled up in our shops—on the railroads which traverse, or are just about to traverse, our continent—on the wealth, the power, the rapid interchange of commerce and intelligence produced by the modern steam engine,—and then let me remind you that all this is the fruit of the solitary labors and studies of a Glasgow work-shop, directed by an active, vigorous, daring, but most patient and persevering mind, which knew how to use well the knowledge that other wise or ingenious men had previously reasoned out or discovered. Much of this stupendous result Watt beheld with his own eyes, for he continued to apply and improve his invention for more than half a century. He lived to see the complete success of its application to navigation by our own Fulton, who, great as were his various merits and inventive resources, would have labored in vain had he been obliged to rely for the moving power of his machinery upon the feeble ancient engines of Savary or Newcomen. Watt died in 1819, full of years and honors.† How splendid a reward of well directed intellectual labor! What an animating excitement is the contemplation of it to the best aspirations of a bold and generous, but also of a wise, a useful, and a benevolent ambition!

I trust that I need adduce no further evidence to shew of what infinite consequence it is to society, that the phenomena and the processes of nature and art should be constantly watched by well instructed eyes, and of what incalculable value the slightest new fact thus gathered, (as in the case of the chemical antidote to the disease of goitre,) may prove to the whole human family. Thus it is, that whether like Dollond, Smeaton, or Watt, you are yourselves the happy agents of spreading more widely the dominion of mind over matter, or whether you merely enrich human knowledge by some single additional fact, the use of which may at some future time be developed by others, you will in either case attain the generous wish so well and strongly expressed in the plain but expressive words of one of the reports of your Institute, and "will leave the world in a better state than you found it."

There is, I think, another and not less wholesome influence upon science, to be derived from its being made familiar to the thoughts of men, whose ordinary habits of life are exclusively practical.

It would be a poor affectation in me, were I to pretend to hold cheap the acquirements of the closet, and the researches and conclusions of retired and speculative philosophy. For in this class must be reckoned the wisdom of Newton, Leibnitz, Euler, Locke, Butler, the great lights of mathematical and physical and moral truth. But it must be confessed, that it is the uniform tendency of all purely speculative and scholastic science, to wander into visionary abstractions, to shroud itself in abstruse technicalities, and, above all, to substitute words of learned length, and rules or maxims of arbitrary authority, to simple and intelligible reason. Thus men of erudition and science often impose upon themselves as well as upon others. Now I can imagine no more effectual corrective to this tendency,

* Mr. Jeffrey.

† Amongst these honors must be particularly noticed two sketches of his character: the one from the pen of Francis Jeffrey, the other from that of Walter Scott. In both of these, those eminent men have done honor to themselves as well as to the memory of their friend, by the warmth of feeling with which they have described his virtues and talents, his amazing stores of miscellaneous knowledge, and that unclouded amiable temper and unflagging benevolence which made this profound philosopher, this creator of power, this potent magician, whose machinery has changed the whole world, to be in private life one of the most delightful of companions, and the best and kindest of human beings.

than the bringing science to the test and the ordeal of the general mind, the applying to its doctrines the reason and the experience of society. Not that every man, nor any one man, can be capable of judging of the soundness or worth of all science; but that the aggregate good sense of the community is thus brought to bear upon the whole body of theory. Mysteries enough in physical and moral nature will still remain; but they will be known and confessed to be so from the present limited powers of the human mind. We shall not think we understand them, because we have good and well sounding words wherewith to conceal our ignorance. Two centuries ago all the wonders of nature were explained, or supposed to be so, by the mystical and imposing maxim that "Nature abhors a vacuum." Then came a theory of *vortices*, or little and great whirlpools pervading all creation, and these too accounted for every thing. We should have never found out that all this was a string of empty words and arbitrary assertion, if men had done nothing but write or talk on the subject. It was the air pump and the barometer, the crucible and the retort, the application of science to the wants of life, that silently refuted it all and substituted more solid knowledge. An excellent writer of our own day, (Mr. Herschell,) to whom I have been before indebted, has so well and strongly stated the truth which I wish to impress, that I should only dilute his sound and manly sense, were I to clothe his ideas in any other words than his own.

"Knowledge can neither be adequately cultivated nor adequately enjoyed by a few. It is not like food, destroyed by use; but rather augmented and perfected. It acquires, perhaps, not a greater certainty, but at least a confirmed authority and a probable duration by universal assent; and there is no body of knowledge so complete but that it may acquire accession, or so free from error but that it may receive correction by passing through many minds. Those who admire and love knowledge, for its own sake, ought to wish to see it made accessible to all, were it only that its elements may be the more thoroughly examined into, and more effectually developed in their consequences, and receive that ductility and plastic quality which the pressure of minds of all descriptions, constantly moulding them to their own purposes, can alone bestow. To this end it is necessary that science should be divested, as far as possible, of artificial difficulties, and stripped of all such technicalities as tend to place it in the light of a craft, or a mystery, inaccessible without a kind of apprenticeship. Science, of course, like every thing else, has its own peculiar terms; and these it would be unwise, were it even possible, to relinquish; but every thing that tends to clothe it with a strange and repulsive garb, and especially every thing that, to keep up an appearance of superiority in its professors over the rest of mankind, assumes an unnecessary garb of profundity and obscurity, should be sacrificed without mercy. Not to do this is to deliberately reject the light, which the natural unincumbered good sense of mankind is capable of throwing on every subject, even in the elucidation of principles. But where principles are to be applied to practical uses, it becomes absolutely necessary; as all men have then an interest in their being so familiarly understood that no mistakes need arise in their application."*

We may remark something analogous to this effect in our personal experience of the operations of our own minds. A man may have worked out in his head a new general rule in arithmetic, or he may plan a large building or scheme out in his mind, a machine in all its parts to his perfect satisfaction. Yet he cannot safely rely upon these mental abstractions, until he reduces them to an actual trial; of the rule, for instance, by working a question or problem with it, of the plan by laying it down on paper, or of the machine by essaying it in a model; in short, as the phrase is, he must see how it works. Then, there is always an even chance that he will find that his general ideas were, if not somewhat erroneous, at least imperfect, that he had overlooked or omitted something essential. But the putting the great body of men of experimental skill in possession of the principles of scientific theory, is precisely the doing, on a very extensive scale, what the individual does on a small one, in such cases as those just mentioned. This will show how the theory works. This tries and proves, or else limits and corrects, the general propositions of speculation, by comparing them with specific examples, and thus submitting them to the experience and common sense of mankind.

This salutary influence of general inquiry and knowledge is by no means limited to pure science. We may go much further. Mathematicians have said, and truly, that the spirit of geometrical reasoning is not limited in its application to mere geometry; but that the method, the clearness, the exactness, that distinguish mathematics, gradually communicate themselves to other studies, opinions and pursuits, so that at length their effect is felt even

* Discourse on the Study of Natural Philosophy, by I. F. W. Herschell.

among those who are ignorant of mathematics. Such, it seems to me, must also be the effect of sound and well digested knowledge, of any kind, upon the general habits of the mind, and ultimately upon all the great interests of society. It forms and strengthens a rectifying and methodizing power of the understanding, such as that for which James Watt and Benjamin Franklin were so eminently distinguished upon every subject that came under their examination. It induces the regular appetite for distinct reason, the desire of light and truth in all things. Now error and fraud love to hide themselves in a cloud of wordy generalities—to imitate mysterious difficulties—to magnify the importance of phrases, or terms, or usages, of ambiguous or of no meaning, though sanctioned by time, or by party, or by authority—in short, to protect themselves and impose upon others by means which, when at length honestly analyzed, turn out to be mere *humbug*. The word is a coarse one, and is branded by critics and dictionary makers as low. I believe it may be so. I can only wish that the thing itself received no more countenance among the great and learned than the word.

But real wisdom and legitimate science, however abstruse or difficult upon the first examination, whatever great and unsurmountable mysteries may be mixed with their certainty, yet dread not the public gaze. They ask no aid from delusion or from ignorance. They claim the light of day, and rejoice and expand themselves in the full flood of its noontide blaze.

Therefore it is, fellow-citizens, that the diffusion of real knowledge, and the universal habit of investigating scientific or moral truth, cannot but ultimately have a most purifying and exalting effect upon our political institutions, our jurisprudence and administration of justice, our civil and even municipal and local policy.

It is sufficient to have indicated these general views: you will yourselves judge of their correctness. I could not enlarge upon them without at least entering upon topics leading to controversial discussion.

I have not yet touched upon the influence of knowledge, such as that to which your institution invites the mechanics of this city, upon the operative and producing classes themselves, in improving the character, raising the thoughts, awakening sleeping talent, and thus qualifying this great and valuable body for the able, just, right, wise, and honorable discharge of all the duties of men, of citizens, of freemen, and of patriots. This is alone and in itself a theme full of interest—full of excitement. As it was doubtless a leading motive in founding this Institution, I had intended to make it the principal subject of this opening lecture. But I found that it was so familiar to the thoughts—I may rather say, to the hearts—of your members, and it had already been so strongly and well urged in the addresses and reports of your committees, that I could add very little indeed to the deep conviction and impression that had already been made. This gives the promise of a noble harvest of usefulness from the seed which may be sown here. But it was for these reasons that I have rather chosen to attempt exciting your minds to the holy ambition of "leaving the world better than you found it," by pointing out what experience has proved that you can do for the cause of science and reason, than to repeat what you already know and feel, and to tell you what science and reason can do for you.

Yet if exhortation on this head were needed, you would find in the history of our own country a lesson to this effect, far more instructive, far more animating, far more impressive, than any that mere rhetoric such as mine could give—than even the highest eloquence could teach. What is the history of our war of Independence, but the story of the struggles of a poor and a peaceful, but a generally educated, well informed people, against cultivated talent, abundant wealth, and disciplined valor? Then, in the glowing language of one of our own bards,*

> Then war became the peasant's joy; her drum
> His merriest music, and her field of death
> His couch of happy dreams
> After life's harvest home.
>
> He battles, heart and arm, his own blue sky
> Above him, and his own green land around;
> Land of his father's grave.
> His blessing and his prayers!
>
> Land, where he learnt to lisp a mother's name,
> The first beloved on earth, the last forgot—
> Land of his frolic youth—
> Land of his bridal eve!

* Halleck. Field of the Grounded Arms.

Land of his children! Vain your columned strength,
Invaders! vain your battle's steel and fire!
Choose ye the morrow's doom,
A prison or a grave.

Such were Saratoga's victors—such the brave men whose blood earned our liberties. Foremost among these was the blacksmith of Rhode Island, NATHANIEL GREENE: he whom Hamilton, whilst he honored Washington as "the first *man* of the country," did not hesitate to style "the first soldier of the revolution."* He was a man not more remarkable for his genius and patriotism, than for his insatiable thirst for knowledge, and the eagerness with which even in early youth he seized upon every opportunity of mental improvement. There also was the bookbinder KNOX, and from among the mechanics of New-York came forth our WILLET,† "the bravest of the brave."

Abroad, our interests were watched over, and our national dignity represented, by the printer FRANKLIN, who, amidst the varied avocations of a busy life, had made himself one of the most accomplished men of the times, and after attaining the highest honors of scientific fame, in his venerable and illustrious old age brought all that learning, science, and fame, to the service of liberty.

Foremost in our councils at home, and enrolled among the immortal names of the committee of five who prepared and reported the Declaration of Independence, was the shoemaker, ROGER SHERMAN, a man self-educated and self-raised. He was one who by mere intellect and knowledge commanded the confidence of the wise and swayed the opinions of the multitude, for he had not the gifts of external show, or "the loud and rattling tongue of saucy and audacious eloquence." As an eloquent colleague of his in the senate and on the bench of justice‡ once described him to be—"he was a slow-spoken and almost tongue-tied man, but his head was as clear as light."

There were other names like these which I cannot now pause to recapitulate. Our more recent history is also full of instances of the most honorable offices of society honorably discharged by men who had enjoyed no higher early advantages than those I have named, but who had used well what they did enjoy.

But I fear to speak of the occurrences or the men of our own days, lest I should seem to play the flatterer. Still I cannot forbear from paying a passing tribute to the memory of a townsman and a friend. It is but a few days ago that the wealth, talent, and public station of this city were assembled to pay honor to the brave and excellent Commodore Chauncey. Few men could better deserve such honors, either by public service or private worth; but all of us who recollected the events of the struggle for naval superiority on the lakes during the late war with Great Britain, could not help calling to mind that the courage, seamanship, and ability of Chauncey would have been exerted in vain, had they not been seconded by the skill, the enterprize, the science, the power of combination, and the ready and inexhaustible resources of his ship-builder, HENRY ECKFORD.

But, fellow-citizens, I must not detain you any longer. I have but to say, that in the examples I have brought before you, you have the earnest, the pledge, the proof of what is in your power to achieve, of what you owe to yourselves and to your country. The ardor for improvement, the thirst for knowledge manifested by the mechanics of this and others of our cities, are gratifying indeed. As they spring from generous motives, as they overshadow and destroy meaner propensities and poorer desires, they afford of themselves no barren subject of gratification to the patriot, the philosopher, and the philanthropist. But they derive a tenfold interest and value from the greater results which they foretell, and the more glorious future they appear to usher in.

Even so, the mild and balmy spring, whilst it gladdens the eye with the young grain, the tender grass, and the white and purple blossoms of the orchard, gives to the mind the cheering promise of the life-sustaining corn, the delicious fruit, and all the riches, the joys, and beauties of serene, bright, and abundant autumn.

* I state this opinion and language of General Hamilton, in relation to the military character of Greene, on the authority of the late Colonel Marinus Willet, (who cordially concurred in the same opinion,) as used by General Hamilton in conversation at a meeting of the Society of Cincinnati, shortly after the death of Greene.

† Colonel Marinus Willet, afterwards Mayor of New-York.

‡ The late William S. Johnson, of Connecticut.

On the Microscope—Method of Constructing, &c. [From Partington's British Cyclopædia.]

The history of this instrument is veiled in considerable obscurity, and among the moderns the discovery of the microscope has been claimed by several individuals. The ancients appear to have been acquainted with it in one of its forms; for Seneca says, "Letters, though minute and obscure, appear larger and clearer through a glass bubble filled with water." In the middle ages this knowledge was lost. The invention of the modern instrument is attributed by the celebrated Dutch mathematician, Huygens, to a countryman of his, named Drebell, who constructed them about 1621, or 31 years after the invention of the telescope. Borelli attributes it to Jansen, the reputed contriver of the telescope; Viviani to Galileo. The first compound microscope, consisting of two double convex lenses, seems to have been made by F. Fontana, a Neapolitan, who dates his invention from the year 1618.

The numerous forms of microscopes may be included under the heads of single, compound refracting, and compound reflecting microscopes. The theory of the *single microscope* may be thus explained: We all know that at a small distance we see more distinctly than at a large. If we look at two men, one 200 feet distant, the other 100 feet, the former will appear only one half the height of the latter, or the angle which the latter subtends to the eye of the observer will be twice that subtended by the former. Hence we must conclude that the nearer we can bring an object to the eye the larger it will appear. Now if, to render the parts of a minute object distinguishable, we bring it very near the eye, (suppose within one or two inches,) it will become very indistinct and confused, in consequence of the great divergence of the rays of light from the object, and the power of the crystalline lens of the eye not being sufficient to collect the rays whereby an image of the object may be formed on the retina at the proper distance on the back of the eye. Now, if we employ a single microscope, which consists of a convex lens, usually made of glass, (though any other transparent substance would have the same power in a greater or less degree,) and mounted in a brass setting, and place it between the object and the eye, the former being in the focus of the glass, the diverging rays from the object will be refracted and rendered parallel by the lens, and thus we shall obtain a distinct and near view of the object. The increase of apparent magnitude obtained by the employment of lenses is proportioned to the difference of the distance of an object from the lens and the distance when seen without its assistance. This latter distance, (the distance of distinct vision of minute objects with the naked eye,) varies in different persons, and at different periods of life. Some measure, therefore, must be assumed as a standard, before we can express the amplifying power of a lens, so as mutually to have the same idea of the magnitude of an object. Some authors adopt ten inches as the standard of the focus of the eye, under ordinary circumstances, and its decimal character makes it a convenient multiplier or divisor. With this decimal standard we can determine the magnifying power of lenses of any focal length, or formed of any substance (media). Thus, if we have a lens which requires for distinct vision the object to be one inch from its centre, (in a double convex,) we must divide the standard ten by one, which will give ten as the magnifying power. If the lens require the object to be $\frac{1}{25}$ of an inch distant, its magnifying power will be 250. We have called the magnifying power in the first instance ten, because the length of the object is increased ten times; but, as its breadth is also increased ten times, the real magnifying power of the lens is ten times ten, or 100. The common form of the magnifiers employed for microscopes is double convex, and they should be made as thin as possible; for the wandering or spreading out of the rays proceeding from an object when refracted by a lens with spherical surfaces, whereby an indistinctness is produced in its image, will be decreased as the square of the thickness of the lens employed, and the loss of light in passing through the lens is less in proportion as it is thin.

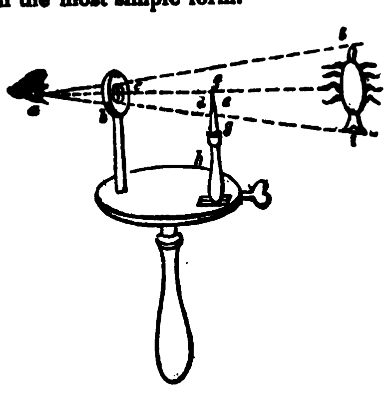
Within a few years diamonds have been formed into lenses in consequence of their high refractive power, whereby we can obtain lenses of any degree of magnifying power with comparatively shallow curves; and, as the dispersion of color in this substance is very low, the lens is nearly achromatic. Next to the diamond the sapphire possesses all the powers requisite for the formation of perfect magnifiers, and presents less difficulty in their construction; hence the expense of employing it is considerably less.

A *compound refracting microscope* is an instrument consisting of two or more convex lenses, by one of which an enlarged image of the object is formed, and then by means of the other, employed as an eye-glass, a magnified representation of the enlarged image is obtained. The distance at which the

two lenses of a compound microscope are placed from each other must always exceed the sum of their focal lengths, in order that the image may be formed by the object-glass in the anterior focus of the eye-glass. Compound microscopes have been constructed of almost all possible dimensions, from a few inches in length to twenty feet; but from experience it appears that whenever their magnitude is augmented beyond a certain point the effect is diminished, though we suppose the amplifying power of both microscopes the same.

The *solar microscope* consists of a common microscope connected with a reflector and condenser, the former being used to throw the sun's light on the latter, by which it is condensed to illuminate the object placed in its focus. This object is also in the focus of the microscopic lens on the other side of it, which transmits a magnified image of it to a wall or screen, (sometimes a combination of two magnifying lenses is used.) The magnifying power will be greater in proportion as the focal distance of the object-glass compared with the distance of the wall or screen from the object-glass is less. The principle of the *lucernal microscope* is the same, except that a lamp is used instead of the sun to illuminate the objects; this lamp is enclosed in a lantern, to screen the light from the observers.

Having thus given a general outline of the arrangement of the microscope in its various forms, it will now be advisable to furnish our readers with such graphic and descriptive particulars as will enable any ingenious workman, reading this article, in conjunction with our treatise on Optics, (which will be inserted hereafter,) to construct the instrument. To render this systematic and intelligible, it may be advisable to commence with the most simple form.



A very convenient form of microscope is shown in the preceding engraving, where *b* is a circular piece of brass or ivory, in the middle of which is a small hole, one-twentieth of an inch diameter: in this hole is fixed, with a wire, a small lens, whose focal distance is *c d*. At that point is placed a pair of pliers, *g h*, which may be adjusted by means of the sliding screw, as in the figure, and opened by means of two little studs. The object may be viewed with the eye placed in the other focus of the lens at *a*; and, according to the focal length of the lens, the object, *f*, will appear more or less magnified, as represented at *i l*. If the focal length be half or one-fourth of an inch, the length, surface, and bulk, of the object will be magnified in a similar proportion. This small instrument may be put into a case for the pocket. Those lenses whose focal lengths are three-tenths, four-tenths, and five-tenths of an inch, are the best for common use.

Since the nearer the eye can approach to an object the larger it appears, it is plain, a double and equally convex lens magnifies more than a plano-convex lens; because, if the sphere or convexity be the same, the focal length of the former is but half that of the latter; and, since the double convex consists of two segments of a sphere, the more an object is to be magnified, the greater must the convexity be, and therefore the smaller the sphere; till at last the utmost degree of magnifying power will require that these segments become hemispheres, and, consequently, the lens will be reduced to a perfect spherule, or very small sphere.

If the radius of the spherule be one-tenth of an inch, the eye will have distinct vision of an object by means thereof, at the distance of 1½ radius, (that is, three-twentieths of an inch,) and, as this is but the fortieth part of six inches, the length of an object will be magnified forty times, the surface 1600 times, and the solidity 64,000 times, by such a small sphere.

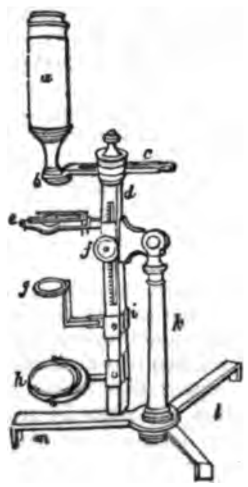
If the radius of a spherule be but one-twentieth of an inch, then will the eye have distinct vision of an object at the distance of three-fortieths of an inch, and as this is but the eightieth part of six inches, the length of objects will appear eighty times greater, the surface 6400 times, and the bulk 512,-000 times greater, to the naked eye at six inches distance.

In using these spherule microscopes, the objects are to be placed in one focus and the eye in the other; and since the focus is so exceedingly near the glass, it is impossible to view any but pellucid bodies; for, if any opaque object were to be applied, the eye being, as it were, just on the spherule, would

entirely prevent any light falling on it, and it would be too obscure to be viewed.

To remedy this inconvenience, the focal length should be increased and a concave mirror substituted for the plate *b*. The object, *f*, being placed in the focus of the mirror, is illuminated by reflected light, and the most opaque insect may thus be seen with advantage to the naturalist. If the instrument thus arranged be directed towards the sun, the effect will be very materially improved; and when this cannot be accomplished, a sheet of white paper should be placed beneath the instrument.

The *compound microscope*, as made by Messrs. Jones, of Holborn, is shown in the engraving beneath. The body of the instrument,



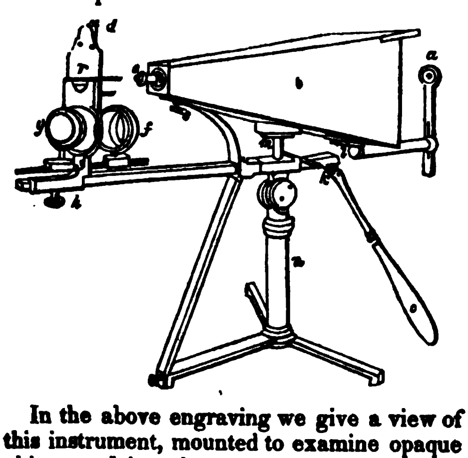
a, is screwed to the horizontal sliding arm, *c*. At *b* is a circular plate, containing a series of glasses, varying in their magnifying power. The objects to be magnified are placed in the stage, *e*, and the proper focus obtained by moving the rack at *f d*. The lens *g* is employed to concentrate the light of a lamp, or that of the sun, on the object to be examined. The reflector at *h* has two mirrors, the one concave, the other flat. The whole instrument is supported by the pillar, *k*, and the triangular stand, *l m*.

The great facility with which objects can be represented on paper, or a rough glass, in the camera obscura, and copies drawn from them by any person, though unskilled in drawing, evidently suggested the application of the microscope to this instrument. The greatest number of experiments that appear to have been made with this view, were by Mr. Martin and Mr. Adams, the former of whom frequently applied the microscope to the portable camera, and with much effect. But these instruments being found to answer only with the assistance of the sun, Mr. Adams directed his experiments to the constructior of an instrument of more extended utility, which could be equally employed in the day and by night. He accordingly succeeded so far as to produce, by candle-light, the images of objects refracted from a single magnifier, upon one or two large convex lenses (of about five inches, or upwards, in diameter,) at the end of a pyramidal-shaped box, in a very pleasing manner, so as to give opaque objects, as well as transparent ones, the utmost distinctness of representation; but still the light of a candle, or lamp, was found generally insufficient to throw the requisite degree of illumination on the objects. The invention of the Argand lamp offered a complete remedy for this defect, by the intensity and steadiness of its light.

The advantages of this excellently-conceived instrument are numerous and important. "As the far greater part of the objects which surround us are opaque," says Mr. Adams, "and very few are sufficiently transparent to be examined by the common microscopes, an instrument that could be readily applied to the examination of opaque objects has always been a desideratum. Even in the examination of transparent objects, many of the fine and more curious portions are lost, and drowned, as it were, in the light which must be transmitted through them; while different parts of the same object appear only as dark lines or spots, because they are so opaque as not to permit any light to pass through them. These difficulties, as well as many more, are obviated in the lucernal microscopes, by which opaque objects of various sizes may be seen with ease and distinctness, the beautiful colors with which most of them are adorned are rendered more brilliant, without changing in the least the real tint of the color, and the concave and convex parts retain also their proper form. The facility with which all opaque objects are applied to this instrument is another considerable advantage, and almost peculiar to itself: as the texture and configuration of the more tender parts are often hurt by previous preparation, every object may be examined by this instrument first as opaque, and afterwards (if the texture will admit of it) as transparent. The lucernal microscope does not in the least fatigue the eye; the object appears like nature itself, giving ease to the sight and pleasure to the mind: there is also, in the use of this instrument, no occasion to shut the eye which is not directed to the object. A further advantage peculiar to this microscope

is that by it the outlines of every object may be taken, even by those who are not accustomed to draw; while those who can draw well will receive great assistance, and execute their work with more accuracy, and in less time, than they would otherwise have been able to have performed it. Transparent objects as well as opaque may be copied in the same manner. The instrument may be used at any time of the day, but the best effect is by night; in which respect it has a superiority over the solar microscope, as that instrument can be used only when the sun shines.

"Transparent objects may be examined with the lucernal microscope in three or four different modes, from a blaze of light almost too great for the eye to bear to that which is perfectly easy to it; and, by the addition of a tin lantern to the apparatus, may be thrown on a screen, and exhibited at one view to a large company, as by the solar microscope."



In the above engraving we give a view of this instrument, mounted to examine opaque objects. *b* is a large mahogany pyramidal box, which forms the body of the microscope; it is supported firmly on the brass pillar, *n*, by means of the socket, *m*, and the curved piece, *e*. *a* is a guide for the eye, in order to direct it in the axis of the lenses; it consists of two brass tubes, *l*, one sliding within the other, and a vertical flat piece, at the top of which is the hole for the eye. The inner tube may be pulled out, or pushed in, to adjust it to the focus of the glasses. The vertical piece may be raised or depressed, that the hole through which the object is to be viewed may coincide with the centre of the field of view; it is moved by a milled screw, which could not be shown in this figure. At *l* is a dove-tailed piece of brass, made to receive the dove-tail at the end of the tubes, by which it is attached to the wooden box. The tubes may be removed from this box occasionally, for the convenience of packing it up in a less compass. At the small end of the cone is placed a tube, which carries the magnifiers, one of which is represented at *c*; the tube may be unscrewed occasionally from the wooden body. Beneath the cone is placed a long square bar, which passes through and carries the stage or frame that holds the objects; this bar may be moved backward or forward, in order to adjust it to the focus, by means of the pinion, *k*. A handle furnished with a universal joint, for more conveniently turning the pinion, is shown at *o*. When the handle is removed a nut may be used in its stead. The stage, *h*, for opaque objects, fits upon the bar by means of a socket, and is brought nearer to or removed further from the magnifying lens by turning the pinion, *k*; the objects are placed in the front side of the stage. The two upper pieces of brass, *r*, are moveable; they are fixed to a plate, which is acted on by a spiral spring, that presses them down, and confines the slider with the objects: this plate, and the two upper pieces of brass, are lifted up by the small nut, *d*.

At the lower part of the stage there is a semi-circular lump of glass, *g*, which is designed to receive the light from the lamp, and to collect and throw it on the concave mirror, *f*, whence it is reflected on the object. The upper part of the opaque stage takes out, that the stage for transparent objects may be inserted in its place.

On the Meteoric Phenomenon of November 13th, 1833. By D. A. Strong. To the Editor of the Mechanics' Magazine.

Sir,—I observed in my last Magazine something respecting the curious display of meteoric bodies on the morning of the 13th of November last, and wish you to state for me, that they all seemed to spring from a point about 30° south-east of the zenith, (as seen from this place,) and that this point remained stationary among the stars while I observed it. I first saw it about a quarter before six, though I was told by others it had been visible for three hours or more, and that the point from which all seemed to emanate had kept its place. However, I thought best to mark the place to determine the fact, and measure its height, should some other at a distance do the same. Accordingly I took a range from one building over the corner of another, marking the place. I also observed the stars nearest the point, but not being acquainted with many of them, I cannot tell their names. In about half an hour I looked at my range: the point had proceed-

ed considerably to the west, but kept its place with regard to the stars, or I should say, so appeared to me. I saw the train, which, like Aaron's rod, turned to a serpent; but should I draw it, I should make it shorter than in the engraving by one-third, and put the head on the other end.

I should have said the point was 30° from the zenith, not exactly south-east, but about 35° east of south, when I first observed it. This I determined by means of a sheet of tin, on which I marked a quarter circle, suspending a bullet by a hair for a plumb. It can be relied on as within a degree of the truth in the first arc or disc from the zenith, but of the other I am not so sure, as I took it from the corner of a street. You must excuse imperfections, as I am not in the habit of writing, and like many other young mechanics, have little of the philosopher about me; I will try, however, to have these bearings taken exactly, as the range remains marked; in the mean time I remain yours, &c. D. A. Strong.

Buffalo, Dec. 14, 1833.

The Meteoric Phenomenon on 13th November, 1833—Keeping Diaries or Daily Journals. By Senex. [From the New-York Farmer.]

Mr. Editor,—The brilliant appearances which took place on the 13th of the present month appear, by the various accounts, to have been observed from Florida to Canada. I have expected that some speculations on the causes or probable effects of so singular a phenomenon might appear in the public papers, but as yet have been disappointed; nor can I pretend to throw any light on the subject, being quite unlearned in matters of this kind. Reading these accounts, however, brought to my recollection a similar appearance which took place in Scotland many years ago, and which I had marked in my daily journal at the time. On looking into the abstract of that for 1779, I find the following noted: "On the morning of the 13th November, from 5 to 8 o'clock, a great many meteors or balls of fire were seen in the air, breaking out with a great flash, which was succeeded by a long streak of light, something like the aurora borealis; and, in the intervals between the larger flashes, a vast number of the small meteors, commonly called falling or shot stars. Many people dreaded that these meteors portended no good; but they were mistaken. On the afternoon of the 13th was indeed a very heavy rain, but it was succeeded by several weeks of mild, calm weather, which gave many people an opportunity to finish their shearing, but was extremely against keeping it in the stack, the greater part of the ricks being obliged to be twice turned, though all built with air vents."

In looking over the journal before mentioned, I could not but remark the similarity of that season to the present. That of 1799, spring, summer, and autumn, was one of the coldest and wettest on record; the crop neither filled nor ripened as usual, and the harvest was not finished in the higher and northern districts of Scotland until the month of December. The season of 1833 has been in many respects similar; although the crops, with the exception of Indian corn, have not suffered like those of Scotland in 1799, yet the season has undoubtedly been colder and wetter than the average of seasons in this country. It may therefore be presumed that the phenomena in question have been produced by similar states of the atmosphere, resulting from a long tract of cold and wet weather. It does, however, appear somewhat wonderful that they should take place on the same day and hour of the year in both instances.

Philosophers may perhaps account for this phenomenon, and explain its causes in a satisfactory manner. It is however scarcely probable that any well-founded opinion can be formed as to its future effects on the weather or season; or whether it may have any influence whatever in that way.

I find by these journals that the winter of 1800 was one of the most severe that had happened for many years. A heavy fall of snow commenced the 2d January, which covered the ground above two feet deep, and remained until the first week of March, a thing very uncommon in any part of Britain.

I think it rather improbable that the present winter may prove a severe one, because we have had three very severe in succession, with colder and wetter summers than ordinary between. The present winter has however commenced earlier than usual; the snow lies at present about nine inches deep here, and has done so since the 25th. We have also heard of it two feet deep in some parts of this State. If it should prove uncommonly severe, it might be considered as a singular coincidence, yet may have no connection with the phenomenon in question, or it may, for aught I know.

I shall finish this communication, already much longer than I intended, by recommending to your juvenile readers, commencing farming operations, the propriety and pleasure of keeping a daily journal. I can, from forty years' experience, say that this practice will be found both very useful and agreeable; with me it has long become a habit, which it would be difficult to give up. Be

sides the facts and observations regarding the farm and garden which it contains, the journal is often referred to for ascertaining facts, dates, and domestic occurrences, regarding which doubt or dispute happens to arise. I can also add, that looking back sometimes into its pages has not unfrequently afforded me pleasure by recalling many agreeable recollections of past scenes, and of old and dear friends, many of whom have left the stage of life. And let it not be supposed that the keeping of a journal is to cost much either of time or trouble: three minutes each evening, and from three to six lines of an octavo page, may be stated as quite sufficient for the average of the year. It is also a very agreeable amusement, as well as very useful, to make an abstract of this journal once a year; this affords a concise history of the farm, and the operations and improvements that have been made from time to time, which will be found more and more interesting to the owner the longer it is continued,—the weather, seasons, experiments, facts and observations of every description too various to be enumerated.

SENEX.

Saratoga County, 30th Nov., 1833.

METEOROLOGICAL RECORD, KEPT IN THE CITY OF NEW-YORK,

From the 10th to the 31st of December, 1833, inclusive.

[Prepared expressly for the Mechanics' Magazine and Register of Inventions and Improvements.]

Date.	*Hours.*	*Thermometr.*	*Barometer.*	*Winds.*	*Strength of Wind.*	*Clouds from what direction.*	*Weather.*
Dec'r 10..	6 a. m.	36	30.00	SW by W	fresh	WSW / WNW	fair
	10	40	30.01	WSW—WNW	..	.. / ..	cloudy from WNW
	2 p. m.	40	30.02	WNW—NW	stormy	WNW	..
	6	39	30.10	NW	fresh	..	..
	10	38	30.15	..	..		..
" 11..	6 a. m.	36	30.16	NNW	..	NW	fair
	10	38	30.18	..	moderate	W by S / NNW	..
	2 p. m.	41	30.11	..	..	W by S	.. haze bank at W
	6	37	30.13	..	..	..	hazy
	10	34	30.14	..	..	..	.. —fair
" 12..	6 a. m.	26	30.20	N by W	..	WSW	fair
	10	28	30.23	..	..	..	..
	2 p. m.	32	30.20	NNW	..		clear
	6	31	30.24	..	..		..
	10	26	30.29	..	..		..
" 13..	6 a. m.	22	30.34	..	light		..
	10	26	30.35	..	..		.
	2 p. m.	23	30.29	NE—SE	faint		..
	6	30	30.30	NE	..		..
	10	26	30.31	..			..
" 14..	6 a. m.	22	30.28	..	mod.-fresh	W by S / NE	cloudy
	10	23	30.28	NE by E	fresh	.. / NE by E	..
	2 p. m.	27	30.14	ENE	strong-gale	ENE	..
	6	31	30.05	..	gale	..	.. —snowy
	10	31	29.93	..	.. —strong		.. —snow
" 15..	6 a. m.	30	29.88	N by E	strong		snow
	10	29	29.93	N	fresh		.. cloudy
	2 p. m.	31	29.99	..	..	N	cloudy
	6	30	30.09	N by W	moderate	NNW	..
	10	29	30.15	..	..		hazy
" 16..	6 a. m.	27	30.25	NNE	..	ENE	cloudy
	10	30	30.27	NE—ENE	..	..	..
	2 p. m.	35	30.24	ENE	..	..	..
	6	34	30.20	..	fresh	..	..
	10	34	30.13	.	strong-gale	..	.. —rainy
" 17..	6 a. m.	39	29.72	..	..*	..	rainy
	10	40	29.63	..—E	heavy gale†	..	rain
	2 p. m.	43	29.50	NE by E	..—mod.	..	.. —cloudy —rainy —rain
	6	42	29.57	..	..	..	..
	10	39	29.60	..	..		cloudy
" 18..	6 a. m.	39	29.63	..	..		..
	10	40	29.67	..	..	NE	..
	2 p. m.	41	29.72	NNE	fresh	..	..
	6	37	29.80	..	..	..	..
	10	35	29.91	..	..	..	..
" 19..	6 a. m.	32	30.00	N by E	moderate	NNE	fair
	10	34	30.18	NNE	..	..	..
	2 p. m.	36	30.19	N by E	..	N by E	..
	6	32	30.24	..	..		clear
	10	29	30.27	..	..		.
" 20..	6 a. m.	24	30.31	N by W	.		..
	10	27	30.36	N	..		..

CITY OF NEW-YORK—CONTINUED.

Date.	*Hours.*	*Thermometr.*	*Barometer.*	*Winds.*	*Strength of Wind.*	*Clouds from what direction.*	*Weather.*
Dec. 20..	2 p. m.	32	30.30	N	moderate		clear
	6	31	30.30	..	calm		..
	10	27	39.32	..	..		..
" 21..	6 a. m.	25	30.28	N by E	light	WSW	fair
	10	29	30.30	..	..	..	..
	2 p. m.	36	30.25	SW—WNW	faint	..	..
	6	34	30.23	S westerly	..	..	cloudy —rain and sleet
	10	34	30.20	..	..	..	rainy—moon visible at times
" 22..	6 a. m.	34	30.10	NNW	..	..	fair
	10	36	30.12	NW	moderate	..—WNW	..
	2 p. m.	40	30.11	..	..	WNW	..
	6	37	30.20	..			clear
	10	35	30.23		calm		..
" 23..	6 a. m.	34	30.25	NNE	faint	W by S	fair
	10	36	30.28	..	..	..	..
	2 p. m.	37	30.24	..	..	..	cloudy
	6	36	30.20	..	..	..	..
	10	36	30.10	..	..		rainy
" 24..	6 a. m.	40	29.82	NE	strong	NE	..
	10	39	29.86	NNE—N	..—fresh	..	..
	2 p. m.	40	29.85	NNW	fresh	{ WSW / NNW }	cloudy —fair
	6	39	29.88	..	moderate	..	..
	10	39	29.88	..			..
" 25..	6 a. m.	38	29.78		calm		.. and foggy
	10	39	29.77	NE	moderate		rainy
	2 p. m.	40	29.60	NNE—N	..		rain —snow and rain
	6	38	29.63	NNW	..		..
	10	36	29.68				rainy
" 26..	6 a. m.	38	29.97	WNW	fresh	{ SW / NNW }	fair
	10	41	30.03	..—W by S	..	..	..
	2 p. m.	39	30.10	W by N	..	W by N	..
	6	35	30.11	W by S—WSW	..		clear
	10	34	30.11	WSW	..		..
" 27..	6 a. m.	32	30.10	W by N	.	..	fair
	10	33	30.11	WNW-W by N	..	..	..
	2 p. m.	34	30.10	W by N	..	..	..
	6	31	30.09	..	..	WNW	..
	10	30	30.09	..	..	..	..
" 28..	6 a. m.	27	30.05	WSW	..	WSW	..
	10	31	30.10	..	..	{ WNW / WSW }	..
	2 p. m.	33	30.08	W by S	..	W by S	cloudy
	6	33	30.04	..	moderate	..	..
	10	33	30.06	..	..	..	..
" 29..	6 a. m.	35	30.14	..	..	W by N	fair and pleasant
	10	37	30.19	..—W by N	..	..	..
	2 p. m.	41	30.20	..—W by S	..	{ WSW / N }	..
	6	36	30.27	WSW	light		..
	10	34	30.30		..		..
" 30..	6 a. m.	33	30.28	ENE	..		cloudy
	10	35	30.35	..	..	S	..
	2 p. m.	36	30.25	..	..	..	rainy
	6	39	30.21	..	faint		..
	10	41	30.17	..	..		..
" 31..	6 a. m.	39	30.02	NNE—N by E	..		cloudy and foggy
	10	41	30.04	N-NNW-W by S	..	WSW	..
	2 p. m.	43	29.96	WSW	moderate	..	fair
	6	42	29 93	..	..	..	..
	10	39	29.96	..	..	..	cloudy

In December, the observations of winds from the North-Eastern quarter, were 79½—from the South-Eastern, 1—from the South-Western, 23—from the North-Western, 43½.

The observations of the direction of clouds or higher currents, for the same month, were as follows: From the North-Eastern quarter, 28—from the South-Eastern, 1—from the South-Western, 53½—from the North-Western, 25½.

Maximum of the barometer 30.50 in.—Minimum, 29.50 in.—Range, 1. in.

* The snow storm of the 14th commenced at Baltimore at half past eleven on Saturday morning, and at Philadelphia at 4 o'clock in the afternoon, and continued about the same length of time as here.

† The storm of the 17th, as well as that of the preceding Saturday, commenced somewhat earlier at the south and later at the eastward than usual; or, in other words, the progress of these two storms from south-west towards the north-east was *slower* than the average of other storms. The storm of the 17th is said to have been near twenty-four hours in travelling from New-York to Portland.

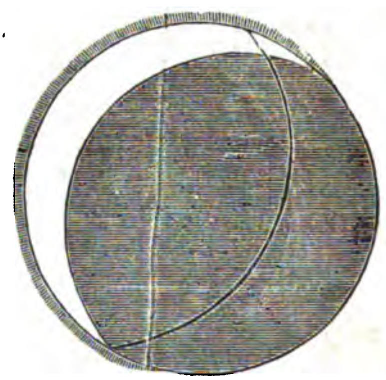
The common notion that the violent westerly wind which commonly succeeds an easterly gale is an opposing or antagonist wind, forcing back the easterly gale, is disproved by the facts attending the gale of the 17th, which, in this part of the country, exhibited no change to the westward—the wind continuing to blow from the north-eastern quarter till long after the gale had passed beyond the eastern limits of the United States. Such facts can be satisfactorily accounted for only by admitting the circuitous or whirlwind character of these storms.

	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	MOON'S PHASES.
Janu'ry				1	2	3	4	3d Q. 2 11 17 M
	5	6	7	8	9	10	11	New 9 6 14 E
	12	13	14	15	16	17	18	1st Q. 17 9 46 E
	19	20	21	22	23	24	25	Full 25 5 17 M
	26	27	28	29	30	31		3d Q. 31 8 20 E
Feb'ry							1	
	2	3	4	5	6	7	8	New 8 0 5 E
	9	10	11	12	13	14	15	1st Q. 16 4 44 E
	16	17	18	19	20	21	22	Full 23 4 5 E
	23	24	25	26	27	28		
March							1	
	2	3	4	5	6	7	8	3d Q. 2 7 21 M
	9	10	11	12	13	14	15	New 10 6 22 M
	16	17	18	19	20	21	22	1st Q. 18 8 5 M
	23	24	25	26	27	28	29	Full 25 1 20 M
	30	31						3d Q. 31 8 32 E
April			1	2	3	4	5	
	6	7	8	9	10	11	12	New 8 11 46 E
	13	14	15	16	17	18	19	1st Q. 16 7 21 E
	20	21	22	23	24	25	26	Full 23 9 42 M
	27	28	29	30				3d Q. 30 11 38 M
May					1	2	3	
	4	5	6	7	8	9	10	New 8 3 28 E
	11	12	13	14	15	16	17	1st Q. 16 2 59 M
	18	19	20	21	22	23	24	Full 22 6 7 E
	25	26	27	28	29	30	31	3d Q. 30 4 0 M
June	1	2	3	4	5	6	7	
	8	9	10	11	12	13	14	New 7 5 0 E
	15	16	17	18	19	20	21	1st Q. 14 8 6 M
	22	23	24	25	26	27	28	Full 21 3 26 M
	29	30						3d Q. 28 9 3 E
July			1	2	3	4	5	
	6	7	8	9	10	11	12	New 6 4 17 E
	13	14	15	16	17	18	19	1st Q. 13 0 19 E
	20	21	22	23	24	25	26	Full 20 2 22 E
	27	28	29	30	31			3d Q. 28 2 13 M
August						1	2	
	3	4	5	6	7	8	9	New 5 1 38 M
	10	11	12	13	14	15	16	1st Q. 11 5 17 E
	17	18	19	20	21	22	23	Full 19 3 17 M
	24	25	26	27	28	29	30	3d Q. 27 6 52 M
	31							
Sept'br		1	2	3	4	5	6	New 3 9 53 M
	7	8	9	10	11	12	13	1st Q. 10 0 32 M
	14	15	16	17	18	19	20	Full 17 6 24 E
	21	22	23	24	25	26	27	3d Q. 25 10 10 E
	28	29	30					
Octob'r				1	2	3	4	New 2 6 4 E
	5	6	7	8	9	10	11	1st Q. 9 11 7 M
	12	13	14	15	16	17	18	Full 17 11 32 M
	19	20	21	22	23	24	25	3d Q. 25 11 31 M
	26	27	28	29	30	31		
Nov'br							1	New 1 3 11 M
	2	3	4	5	6	7	8	1st Q. 8 1 35 M
	9	10	11	12	13	14	15	Full 16 5 54 M
	16	17	18	19	20	21	22	3d Q. 23 10 38 E
	23	24	25	26	27	28	29	New 30 1 51 E
	30							
Dec'br		1	2	3	4	5	6	1st Q. 7 7 47 E
	7	8	9	10	11	12	13	Full 15 11 58 E
	14	15	16	17	18	19	20	3d Q. 23 7 52 M
	21	22	23	24	25	26	27	New 30 2 16 M
	28	29	30	31				

SOLAR AND LUNAR ECLIPSES IN THE YEAR 1834.—*First*, a small eclipse of the sun, on the 7th day of June, at 5 h. 2 m., invisible at New-York.

Second.—A total eclipse of the moon on the 21st day of June, in the morning, visible at New-York, as follows:
Beginning of the eclipse, at 1 h. 58 m.
Beginning of the total darkness, at 3 h. 1 m.
Middle of the eclipse, at 3 h. 43 m.
Ecliptical conjunction, at 3 h. 46 m.
End of total darkness, at 4 h. 25 m.
End of the eclipse, at 5 h. 28 m.
Digits eclipsed, 17¾ from the south side of the earth's shadow.

Third.—A large eclipse of the sun on the 30th of November, in the afternoon, visible at New-York, as follows:
Beginning of the eclipse, at 1 h. 6 m.
Greatest obscuration, at 2 h. 29 m.
Apparent conjunction, at 2 h. 30 m.
End of the eclipse, at 3h. 47 m.
Digits eclipsed, 10° 36′ on the southern limb of the sun, as represented in the following figure; the dark curved line represents the moon's centre across the sun from west to east.



The sun will be centrally and totally eclipsed on the meridian in latitude 40° 16′ north, and longitude 23° 33′ west from New-York.

The sun will be totally eclipsed at Charleston, South Carolina, and at Augusta, in Georgia, and many other places in the states of South Carolina, Georgia, Alabama, Tennessee, and Missouri, &c.

Fourth.—Of the moon, on the 15th day of December, in the evening, visible as follows at New-York:
Beginning of the eclipse, at 11 h. 4 m.
Middle of the eclipse, at 0 h. 20 m.
End of the eclipse, at 1 h. 30 m.
Digits eclipsed 7° 40′ on the moon's southerly limb.

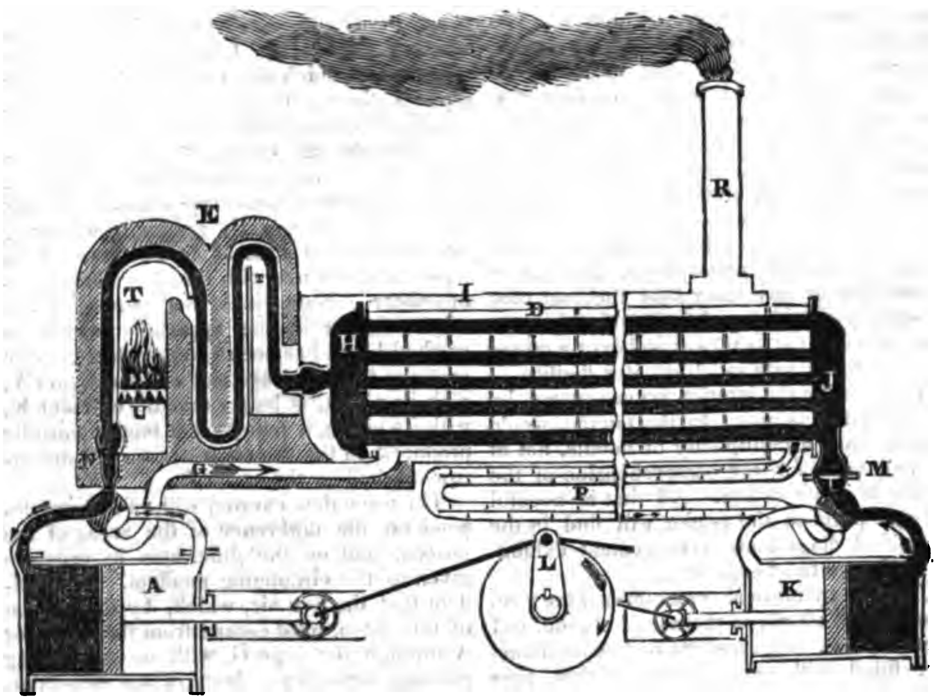
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FEBRUARY, 1834. [NUMBER 2.

When we reflect that *heat* is the great agent in numberless important processes of chemistry and domestic economy, and is the actuating principle of the mighty steam engine which now performs half the work of society, how truly may heat be considered as the life or soul of the universe.—DR. ARNOTT.



ERICSSON'S CALORIC ENGINE.—In our number for December we promised a description of Mr. Ericsson's Caloric Engine as soon as it could be procured. We have much satisfaction in being thus early able to redeem that pledge. The following is from the London Mechanics' Magazine:

The susceptibility for heat, possessed by gaseous and fluid bodies, is known to be nearly unlimited. Neither density nor pressure seems to exercise the smallest counteracting influence. The densest medium will take up a given quantity of heat with as much facility as the rarest; and when two mediums of unequal temperatures are brought in contact, they become equalized immediately, no matter how different their densities may be.

We have now to direct the attention of our readers to a mode of applying these physical truths to the production of mechanical power, which seems to us to be not only decidedly novel, but to be fraught with results of the greatest public importance.

We allude to the patent recently taken out by Mr. Ericsson, for what he calls his "Caloric Engine." The grand feature by

which this engine is distinguished from the steam engine, and all other power machines, is this, that the same given quantity of heat which sets it in motion is used over and over again to keep up that motion, and that no additional supply is wanted beyond what is requisite to compensate for a small loss incurred by escape and radiation.

We have seen, as well as hundreds of others, during the past week, an engine constructed on this plan actually at work, and can bear our personal testimony to its working as powerfully and equably as any steam engine could do.

The engine which we saw at work is, in all external respects, saving only the small space which it occupies, exactly similar to a high pressure steam engine. It is calculated to be of five horse power. There are two cylinders: one called the cold cylinder, 10½ inches in diameter, and the other the working cylinder, 14 inches in diameter, both with an 18 inch stroke. The engine was worked under a pressure of 35 lbs. to the square inch, and its power checked by a break, loaded with 4,000 lbs., acting on the circumference of a wheel of 2 feet diameter.

The circulating medium employed in this engine is simply atmospheric air; but of course that or any other fluid medium may be employed with equal facility for the purpose of using the heat over and over again—some perhaps with much greater facility.

To describe the interior arrangements, by which motion is given to the engine, would lead us into a multiplicity of details, not at all necessary for the comprehension of the principle of its action. All that is needful for this purpose the reader will find in the simplified diagramatic arrangement exhibited in the prefixed engraving.

D D is a cylindrical vessel termed the "regenerator," which, in the actual engine, is 7 feet 6 inches long, and 8½ inches in diameter, fitted with small tubes, which pass through both ends, and terminate in the caps H and J. It also contains a number of division plates, through which these tubes pass, and which plates have segments cut out alternately from their tops and bottoms. The tubes themselves likewise contain a number of small divisions, tapering off towards the centre, each placed in an opposite direction to the other. T T is one of a series of bent tubes, inclosed in a stove, E, and acted upon by the fire, U, the combustion being supported by the draft produced by a chimney, R. The pipes in the stove are all connected with two larger pipes, the one of which communicates with the cap, H, and the other, as shown by the diagram, communicates with a four-way cock, attached to the passage-pieces of a cylinder, A, which is the working cylinder of the engine. P represents one or more pipes, exposed to some cooling medium, and is termed the "cooler;" it contains also a number of division plates, similar to those in the tubes of the regenerator, as also with the four-way cock attached to the cylinder K.

The whole of the apparatus, namely, the body of the regenerator, its tubes, the caps H and J, the pipes in the stove, the cooler P, pipe G, and the two cylinders, with their passage-pieces, we will now suppose to be all charged with common air, or any other aeriform substance. We will suppose also that the portion of that air which is marked black in the diagram is kept under greater pressure or more compressed than the rest, which is left blank. Let us suppose farther, that the air which the cylinder A, the stove pipes T, the cap H, and the pipe G, contain, is raised to some considerable temperature, and that the air contained in the body, as well as the air in the tubes of the regenerator, is nearly of the same temperature of that nearest to the cap H, gradually lessening towards the cap J, so as to be there of an equal temperature with the surrounding atmosphere. Now, since that portion of the air contained in the apparatus which is marked black has been changed to a greater pressure than the rest, and as the cylinder A, with its piston, is larger than the cylinder K, with its piston, it follows that motion must be produced in the direction shown by the arrow marked on the crank L.

The force thus exerted will, of course, depend on the difference of the areas of the pistons, and on the difference in pressure given to the circulating medium. It is evident that the hot air, which, by the motion of the piston, must escape from the cylinder A through the pipe G, will, in its winding passage through the body of the regenerator towards the cooler P, give out its heat to the cold air forced from the cylinder K, the particles of the latter being also in a constant state of change in passing through the tubes towards the stove pipes. The pistons having performed the full stroke, the two four-way cocks are then reversed, when a retrograde action takes place; the motion of the opposite currents in the regenerator still continuing the same as before. A constant motion will thus be produced, and a constant transfer of heat kept up. The object of the cooler P is to abstract the heat, which, on account of the different capacities for heat of the two currents, is not taken up in the regenerator, and the object of the stove is to

supply the heat thus carried away, as well as to compensate for losses by radiation, and to raise the temperature at the commencement.

It need hardly be stated that the lesser volume of air coming from the cold cylinder fills the larger space in the hot cylinder, because it gets heated in passing through the regenerator and through the stove; while on the other hand, the larger escaping volume from the hot cylinder finds room in the lesser space of the cold cylinder, because it parts with its heat before getting there.

By charging the apparatus, the circulating medium may, of course, be kept under any desirable pressure, and thus the power of the engine varied at pleasure. High pressure will naturally produce the greatest proportionate effect, the loss by radiation being the same under whatever pressure.

We were anxious to satisfy ourselves as to the equality of the action of the engine, and with this view timed it repeatedly: the number of strokes was regularly 56 per minute.

The total consumption of fuel, when the engine is working at this rate, is stated to be no more than two pounds per horse power in the hour; and the entire loss of heat incurred by the transferring process (that is, the whole heat carried away by the cooler,) is estimated not to exceed the product of 3 lbs. of fuel per hour. That the fuel required is not even less than two pounds, is solely owing to the great radiating surfaces unavoidable in an engine on a small scale, and to these radiating surfaces not having in the trial engine been covered by any non-conducting substances.

Mr. Ericsson has published a pamphlet explanatory of the principle and construction of his caloric engine. We extract from it the following additional information:

"By keeping the pipes in the regenerator so charged with air as to support a column of mercury 56 inches high, the greatest effect is produced in the trial engine. By the manner in which the side-valves are worked, the pressure in the body of the regenerator always adjusts itself, so as to support a column of mercury 18 inches high; so that an effective pressure, equal to 38 inches of mercury, is kept up. A break, well oiled and loaded, with 5,000 lbs. weight acting on the circumference of a wheel of two feet diameter, fixed on the fly wheel shaft, will at the above pressure keep the speed of the engine at 55 revolutions per minute. At this speed, 176 cubic feet of heated air, of a mean pressure of 17 lbs. to the square inch, are admitted into the working cylinder per minute, thereby exerting a force equal to 431,970 lbs. moved through the space of one foot: thus $\frac{431,970}{33,000} = 13$ horses' power are communicated to the main crank of the engine. The estimating this power is, however, of no other use than to give an idea of the amount of friction to which the crank-engine is subjected. In the same space of time, or a minute, 94·6 cubic feet of cold air, of a mean resistance of 14 lbs. to the square inch, are forced or put into circulation by the cold cylinder, and equal to a resistance of 190,575 lbs. moved through the space of one foot. This amount, divided by 33,000, will give 5·7 horses' power required to work the cold cylinder—hence the two cranks give and receive the power of upwards of 18 horses. By communicating the power of the hot cylinder to the cold cylinder in a direct manner, the available power, setting frictions aside, would be 431,970—190,575=241,395 lbs. moved through the space of one foot. This is equal to $\frac{241,395}{33,000} = 7{\cdot}3$ horses' power—deducting 2·3 horses for frictions would leave 5 horses. On these grounds the trial engine has been estimated at 5 horses' power. The transferring process has succeeded to such an extent, that out of the 10 lbs. of fuel which the engine consumes per hour, the product of heat from 3 lbs. of fuel only are wasted or carried away by the cooler. This important fact has been ascertained by immersing the cooler in a cistern containing precisely 1081 lbs. of water, and by observing the elevation of temperature after an hour's work of the engine; and the increase of temperature in that time is not quite 20 degrees—one pound's weight of fuel being capable of raising the temperature of 9,000 lbs. of water, it follows that the 1081 lbs. contained in the cistern would be raised 8·3 degrees by the combustion of 1 lb. of fuel, and hence that the actual increase of 20 degrees of temperature is effected by the combustion of less than 3 lbs. of fuel. The great discrepancy between the quantity of fuel thus wasted, and that actually consumed by the engine, must be accounted for by the fact, that a considerable extent of radiating surfaces are exposed to the cooling influence of the atmosphere without being surrounded by any imperfect conductors."

Further Experiments on the Liverpool and Manchester Railway, to determine the correctness of the Undulating Railway System.

[From the London Mechanics' Magazine.]

Sir,—Since I had last the pleasure of addressing you, we have been enabled to try some further experiments on the Liverpool and Manchester railway, the decisive result of which will, I doubt not, fully establish, in your mind and in the public opinion, the merits of the undulating principle.

On Wednesday last, the 16th instant, we met as before on *the Sutton inclined plane*. On this occasion it was agreed by the engineers present, viz. Mr. Robert Stephenson, sen., the Messrs. Dixons, Mr. Dagleish, and myself, that the truth and validity of the principle, as well as the comparative advantage to be derived from its adoption, would be effectually determined by the following test:

As great a velocity as possible being attained by the engine and load, before reaching a *given point* near the foot of the inclined plane, the *time* was to be *accurately* ascertained which the train occupied in *ascending from that point to a state of rest*.

The power being thus reversed, the time was to be accurately measured which the train occupied in *descending from a state of rest to the point* from which it had previously *ascended*.

Hence it would be obvious, that if the *descent* were made in less time than the *ascent*, the velocity generated at the foot of the plane would be proportionably greater than the velocity of the ascending train at the same point, and, consequently, the demonstration would be clear that the engine and train would not only have ascended to an opposite elevation equal to that from whence it fell, but to a *greater one*, the extent of which would be in proportion to the velocity attained.

Experiment 1.—The "Liver" engine, and a load of thirteen waggons (weighing in all 72½ tons,) after traversing a distance of three-fourths of a mile to acquire a sufficient velocity, ascended the inclined plane 278 yards, the time occupied in performing the ascent to a state of rest being 90 seconds, viz. velocity at foot of plane being about 12.60 miles per hour, and the average velocity about 6.30 miles per hour.

Experiment 2.—The *power being reversed*, the engine and train *descended* 278 *yards*, viz. from a state of rest to the point from which they had previously risen, in 50 *seconds*. The velocity at the foot of the plane being about 22.70 miles per hour—average velocity about 11.35 miles.

Experiment 3.—The engine and train having traversed ¾ mile to generate velocity, ascended to a state of rest, viz. about 278 yards in 75 seconds. Velocity at the foot of the plane being about 14.12 miles per hour—average velocity about 7.6 miles.

Experiment 4.—The power being reversed, the descent of 278 yards was accomplished in 40 seconds. Velocity at the foot of the plane being about 28.32 miles per hour—average velocity 14.16 miles.

Experiment 5.—The ascent of 278 yards was made in 80 seconds. Velocity at the foot of the plane being about 14.22 miles per hour—average velocity 7.11 miles per hour.

Experiment 6.—The descent of 278 yards was accomplished in 49 seconds. Velocity at the foot of the plane being about 23.22 miles per hour—average velocity about 11,61 miles per hour.

AVERAGE.

	Total spaces passed over to generate maximum velocity before ascending.	Times occupied in ascending 278 yards.
Experiment 1	1,320 yards	90 seconds.
Experiment 3	1,320 yards	75 seconds.
Experiment 5	1,320 yards	80 seconds.
Total	13,960 yards	245 seconds.
Average	1,320 yards	81⅔ seconds.

	Total spaces passed over in generating maximum velocity in descending.	Times occupied in descending 278 yards.
Experiment 2	278 yards	50 seconds.
Experiment 4	278 yards	40 seconds.
Experiment 6	278 yards	49 seconds.
Total	834 yards	139 seconds.
Average	278 yards	46⅓ seconds.

From the preceding statement it appears, that the utmost average maximum velocity which the Liver engine could attain on this occasion, at the foot of the plane, after traversing a distance of 1,320 yards, was about 13.926 miles an hour; by which means, the power being continued, she was enabled to ascend an inclination of 278 yards.

On the other hand, it appears that the same engine, with the same load, (the steam being kept up in every instance to a pressure of about 50 lbs. to the inch,) generated a velocity, after descending 278 yards, of about 24.488* miles per hour, evidently proving that the engine and train would not only have mounted another summit of equal elevation to that from whence it fell, but would, *at the highest point*, have been travelling at a velocity of more than ten miles an hour, with the full means of increasing that velocity to any desired extent over the succeeding undulations.

Although the preceding experiments had, to the satisfaction of all present, decided the superiority of the undulating principle, I was anxious to know the result of a trial with a *double load*. I therefore proposed (it being too late an hour on this occasion) to attain, on a future day, a a velocity of twenty miles an hour, with a double train of goods and two engines. I had, on several occasions, published my opinion of what that result would be, and I have now the satisfaction of adding the particulars of this important experiment, which, I need not say, *more than confirms* all my anticipations.

On Sunday morning last two locomotive engines, viz. the "Firefly" and the "Pluto," left Manchester with a train of loaded waggons, weighing 150 tons, exclusive of engines and tenders, the whole length of the train being about 150 *yards*.

On arriving at the Sutton inclined plane, it was determined to adopt the same method as on the last trials, of proving the merits of the principle. Our reason for appointing Sunday for this meeting will be obvious, when it is considered how dangerous and inconvenient it would be to try experiments with such a load on any

* The velocity in these instances is calculated from the *average* number of seconds occupied in ascending and descending; thus, 278 yards being = about 6⅓ of a mile, we have the descending line 46⅓ × 6⅓ = 294, and 3,600 seconds ÷ 294 × 2 = 24.488 maximum velocity

other day, when the trains are almost constantly passing and repassing.

It may be known to some of your readers, that the French government have lately appointed a certain number of their most eminent engineers to visit this country, with a view of acquiring all requisite information, preparatory to the construction of several intended French lines of railway.

These gentlemen, nine in number, were present on this occasion; their names were as follows—Mons. Navier; Mons. Goubeau, Jugement des Ponts et Chausses; M. Arnollet, Ingenieur en chef du Ponts et Chausses, a Dijon; M. Engene Nuneann, Ingenieur des Ponts et Chausses, No. 1 Rue Castiglione, Paris; Mons. Dausse; Mons. L. L. Vallee, Ingenieur en chef des Ponts et Chausses; Mons. J. Moistard, Ingenieur de la Marine; Mons. Paris, Lieutenant de Vaisseau; Mons. K. Mamgan.

The English engineers present were Mr. R. Stephenson, sen., of Manchester, (with whom I have recently entered into partnership as civil engineers,) Mr. Dagleish, sen., Mr. Dixon, sen., Mr. Dagleish, jun., and myself. In addition to whom were many other individuals deeply interested in railways, and of general scientific acquirements, among whom were Mr. Case, of Summer-hill, near Liverpool, Mr. Garnett, of Manchester (editor of the *Guardian*), and others.

The following statement cannot fail to form an interesting part of your publication:

Experiment 1.—Two locomotive engines, the Firefly and the Pluto, being attached to the train above mentioned, and having traversed a distance of *one mile*, to generate a sufficient velocity, arrived at the point from whence the ascent was to be measured, at a velocity of about 20.28 miles per hour. The Pluto then left the train, and the Firefly alone ascended with the load (working the whole way) to a distance of 575 *yards*, 116 *seconds*—average velocity being about 10.14 miles an hour.

Experiment 2.—The power of the Firefly being reversed, the *engine and load* descended 575 *yards* in 74 *seconds*. The velocity at the foot of the plane being about 31.70 miles per hour—average velocity about 15.85 miles per hour.

Experiment 3.—The Firefly and Pluto having traversed the same distance as before, generated, at the foot of the plane, a velocity of about 14.34 miles per hour. The Pluto then left the train, and the Firefly and load ascended (power working) 315 *yards* in 90 *seconds*—average velocity about 7.17 miles per hour.

Experiment 4.—The power of the Firefly being reversed, the whole train descended 315 *yards* in 65 *seconds*. Maximum velocity 19.82—average velocity 9.91.

Experiment 5.—The same engines and load, working about 1¼ miles to generate velocity, attained at the foot of the plane a velocity of about 18.32 miles an hour. The Pluto left as before, and the Firefly and load rose 457¼ *yards* in 102¼ *seconds*—average velocity about 9.16 miles per hour.

Experiment 6.—The Firefly and train descended 457¼ *yards* in 80 *seconds*. Maximum velocity 23.22 miles per hour—average velocity 11.61.—N. B. In this instance some delay occurred in reversing the power, which will account for the comparative difference in time.

Throughout the whole of these experiments it will be seen the results were so much in favor of the undulating system, that it was evident a *far greater* load than 150 *tons* could be moved by the Firefly, at an average velocity of 15 miles per hour from one summit of a curve to another. The dip of inclination being about 1 in 99, and the total length of the undulation varying from 630 to 1,150 yards.

This led me to propose a further experiment, and I think I may safely add, that one more important in result was never before tried in any country.

Experiment 7.—The two engines, as before, attained at the foot of ascent a velocity of about 19.04 miles per hour. The Pluto then left the train, and, at the same moment, the Firefly SHUT OFF HER STEAM. The whole train then rose by *momentum alone* (the weight of the train, including engine and tender, being near 164 tons,) to the distance of 323 *yards* in 79 *seconds*—average velocity about 9.52 miles per hour.

Experiment 8, *and last*.—The Firefly and train descended 323 *yards* (power working) in 66 *seconds!* Velocity at foot of the plane being about 20.04 miles per hour—average velocity about 10.02 miles per hour.

Thus the preceding experiments most unquestionably prove two most important facts—not only that a given locomotive power can convey from one summit of a curve or undulation, to another summit of equal altitude, *double the load* which that same power can convey at the same velocity on the level; but that a given locomotive engine can convey, from one summit of a curve or undulation to another summit of equal altitude, *double the load* which it is capable of moving on a level at a like velocity (see last experiment), *by the employment of the steam force throughout only half the distance!*

These results lead me to go *one step farther*. It is my opinion, that if such a weight were to be added to the 150 tons moved on this occasion, as would be a *maximum* load for *three locomotive engines* on a level at 15 miles an hour, the Firefly alone (her power being equal to either of the other engines) *would move* the whole train from one summit of a curve to another of like altitude, at an equal average velocity, viz. 15 miles per hour.

If any of your readers, whether witnesses or otherwise of these interesting experiments, can correct any error of opinion or of statement in allusion to them, I shall be exceedingly happy to recognize and acknowledge it. In the mean time I think, Sir, I may congratulate myself upon having stamped, by this letter, a value that will be long appreciated on the correspondence (*pro* and *con.*) which your Magazine contains on this subject; and I am as happy in feeling that every individual who witnessed the recent experiments was fully satisfied with the

importance of the results, as in believing that, in defiance of prejudice and long-formed erroneous opinions on this subject, the public will before long acknowledge, appreciate, and be benefitted by the "UNDULATING PRINCIPLE."

I am, sir, with great respect, your very obedient servant, RICHARD BADNALL.

P. S.—I have not yet seen your last Number. "S. Y.'s" remarks in the previous one shall be noticed. In the mean time, he does me injustice in supposing I have ever indulged one contemptuous feeling toward him. I could not indulge it to a worm—much more to an individual whose good motives, in a scientific discussion, I have never questioned, and in answer to whose remarks I have bestowed time, attention, and labor

Fig. 1.

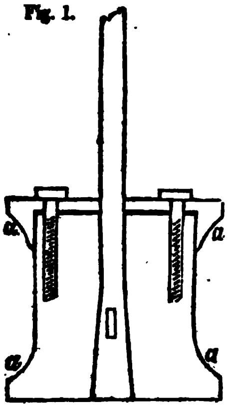
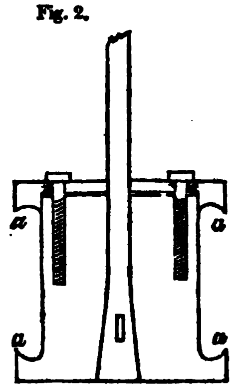


Fig. 2.



Improved Method of Packing Pistons. By T. B. S. To the Editor of the Mechanics' Magazine.

Knowing that many of your readers take a lively interest in whatever contributes to the perfection of the means by which the mighty energies of steam are directed in channels of usefulness, I submit a brief description of an improvement in a minute though an important part of the steam engine. Many expedients have been devised to avoid the use of hemp for the packing of the piston; various metallic substances have been substituted, and numberless other materials long since condemned after repeated trials.

While the piston as adopted by the ingenious Mr. Watt continues in almost universal use, and until a cheap and more enduring piston is discovered, it will doubtless continue to be the favorite plan. In one of its features, however, I consider it susceptible of improvement.

Heretofore engineers have considered it important to form the projecting parts of the piston and follower so as to crowd the hemp outward against the cylinder, as the follower is screwed down to its place. The sketch, fig. 1, is about the form usually given to the metallic part of the piston, and shows the form of the recess for the reception of the packing. It is apparent that the obtuseness of the corners at *a*, *a*, *a*, *a*, are well calculated to avoid the packing as it becomes chafed by friction against the cylinder, while the general shape of the recess greatly conduces to an excessive friction near these angles. Fig. 2 represents the improved form of the piston as I have applied it in several instances, and with success. The acuteness of the edges, *a*, *a*, *a*, *a*, is calculated to preserve the packing from chafing, to hold it in a body to its place, and will retain it, even though worn to fragments, or otherwise reduced, as it may be liable from a variety of causes. Most of the engines in use have pistons of the former description, and the experiment may be tried with a trifling expense, simply by turning a cavity as near to the form of that in fig. 2 as the substance of the piston will allow.

In the hope that some may derive a benefit from the suggestions, as well as to contribute a mite to the interest of your valuable periodical, I offer them.

I am, yours, &c. T. B. S.

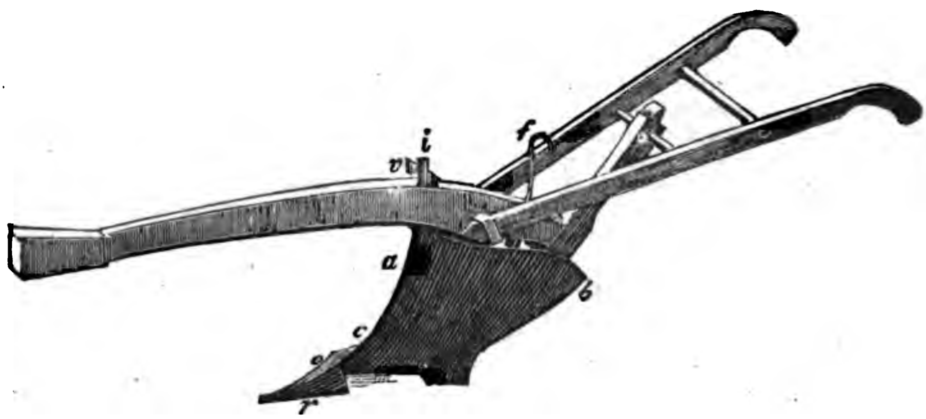
New-York, Jan. 24, 1834.

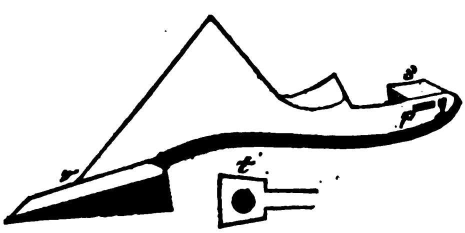
C. H. M'Cormick's Self-Sharpening Horizontal Plough. [Communicated by the Inventor for the Mechanics' Magazine.]

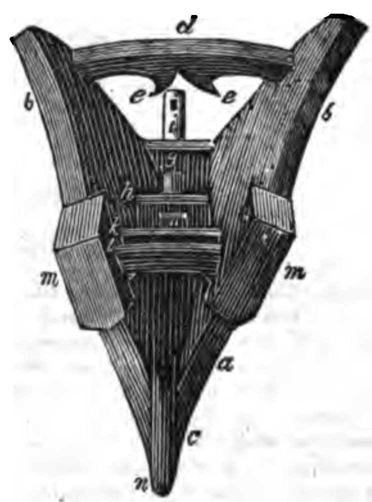
Be it known, that I, Cyrus H. M'Cormick, of Rockbridge county, and State of Virginia, have made an improvement in the useful arts, being a "self-sharpening horizontal plough," which is described as follows:

This plough, like most others, consists of a beam, handles, helve, mould-board, and share. In addition to these there is a latch-rod to make fast the mould-board and share, when changed to either side, and a main bolt to support the mould-board.

The beam, handles, and helve, are similar to those employed in other ploughs. The mould-board, represented at *a* in the annexed drawings, is made double, of cast iron, curved somewhat like other mould-boards, on both sides. The wings, *b b*, are united in part at *c*, and extend outward, making a suitable angle for turning over the earth. There is a brace, *d*, extending between the two wings, behind, supporting them firmly with projections, *e e*, on one side, for receiving the latch-rod, *f*, when changing the plough. Between the wings on the top, and near the front, is a brace, *g*, and another, *h*, near the middle, through which there are openings for the main bolts, *i*, to pass. Near the bottom of the mould-board are two







other braces, *k*, *l*, at about one inch apart, for receiving the hinder end of the share, and between which it plays and turns. Near the ends of these braces, and upon the lower side of the mould-board, are two projections, *m m*, upon which the mould-board slides alternately. These projections can either be cast solid, with the mould-board, or be made of steel or cast iron, and be rivetted on. These projections serve also to hold and support the share when turned. At the front end of the mould-board is cast on it a projection, *n*, which serves as a pivot, on which the share turns.

The share, *o*, is made of cast or wrought iron, in a triangular shape. It consists of the neck, *p*, (with or without a head,) and a slat, *g*, for a key, placed behind the braces; also, a point, *r*, either cast on the share or made separately, and fastened on it by being riveted, or otherwise.

There is also a shoulder, or projection, *s*, by means of which and the latch-rod the share is kept in its place when changed. In the hinder end of the point is a cavity, *t*, to admit the point on the mould-board, upon which and the neck the share turns.

The *main bolt*, *i*, is made of wrought iron, and passes through the beam, and the two openings in the braces of the mould-board before mentioned having a head, *u*, on the lower end, and either a screw or key, *v*, on the head above the beam.

The *latch-rod*, *f*, is a plain curved rod of wrought iron, which extends from above the beam to the neck of the share, and is moveable from one side of the beam and mould-board to the other, passing between the beam and the projections on the brace of the mould-board, and entering between the neck of the share and the wing of the mould-board, and by which the mould-board and share are screwed in the position required.

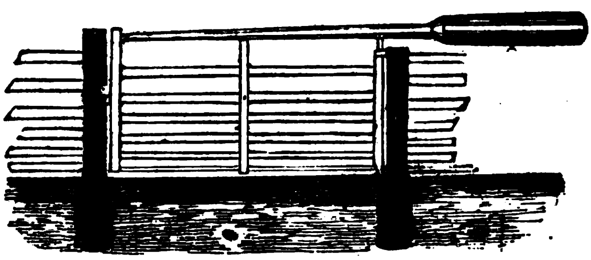
Operation.—When required to plough on a hill-side, say the declination of the hill is on the right, the right wing of the mould-board and share must stand out from the beam to the right, and the other wing of the mould-board being nearly parallel with the beam, forms the land-side, the latch-rod being put in its proper place. One furrow being made in this position, the latch-rod is taken out, and turning the plough, resting on the share, the share is turned on the point of the

mould-board, to the other side, or left, and the mould-board also changes sides. The left wing projecting out to the left, the right wing forming the land-side, the latch-rod is passed between the other side of the beam and the other projection on the brace, the points entering again between the neck of the share and other wing of the mould-board, which pressing the shoulder on the share, above that on the mould-board, makes it fast. The neck of the share might be made to turn on a pivot or collar on the centre, instead of the opening between the braces. A nail or pin is driven in the helve, below the brace, to prevent the mould-board from sinking behind, or the beam from rising, to steady the plough.

The invention here claimed, and desired to be secured by letters patent, consists in the peculiar arrangement and construction of the several parts of the plough, as before described, and particularly the mode of forming the point at the end of the mould-board on which the share turns; and the two braces with the space between them, in which the neck of the share works; the brace near the centre of the mould-board; the two projections on which the mould-board slides; and the share, with the mode of turning and fastening it by the latch-rod.

Done at the city of Washington this 29th day of October, 1833.

CYRUS H. M'CORMICK.



Balance Gate. By D. LAPHAM. [From the Farmers' Reporter.]

SIR,—If the following improvement in the construction of farm gates should be deemed of sufficient value to be of use to the farmers of this country, you are requested to make it known to them through the medium of your valuable paper.

This gate consists of two main posts, set firmly in the ground at the proper distance asunder, in the line of the fence; that part which is above the ground is made about 12 inches square, and the lower part is left round, forming a shoulder at the surface of the ground. These posts have mortices on the exterior sides to receive the rails of the fence. The gate itself is formed of three posts of scantling, 4 by 5 inches square, into which are framed about six strips of 1¼ inch boards, 4 inches wide, so as to form a rectangular gate of the length and height required. Upon the top of these posts rests a beam, which extends back far enough just to balance the gate. The heel-post, upon which the gate turns, rests upon the shoulder of the main post, at the surface of the ground, where there is a depression made to receive it, and it is secured at the top by a staple, or hoop of iron, passing around it, (the upper part of the post being rounded for that purpose,) and is fastened into the main post. The latch or fastening is formed by making one of the slats pass through the front post in a long mortice; and the slat being cut in two at the middle post, and secured by a pin, the piece can be raised or lowered in such a manner as to latch and unlatch the gate. The notch is cut out of the main post, to receive the latch in such a manner as to allow the gate to open either way. This gate is much neater, more substantial, and is less liable to get out of repair, than those formerly in use. There are two gates of this description on the farm where my father resides, in the north part of Champaign county, and he intends soon to have one to each of his fields. D. LAPHAM.

Cincinnati, Ohio, Dec. 19, 1833.

Observations on Architectural, Rural, Domestic, and other Improvements. By ELEAZAR LORD, of New-York. [From the American Journal of Science and Arts.]

NEW-YORK, July 23, 1833.

TO PROFESSOR SILLIMAN:

SIR,—I observed recently in one of the public prints, a brief notice of an association of gentlemen in your city, for the purpose of ascertaining and recommending the best plans and models of domiciliary architecture. The questions to be investigated relate, as near as I remember, to the architectural proportions, materials for building, and methods of warming and ventilating apartments, by

which durability, economy, and convenience, may be combined with elegance and taste.*

These, in every point of view, are questions of great interest. They concern not only the thrift and comfort of individuals and families, but likewise the health, the social character, and indirectly, the morals of households and communities; and considered in these relations, they are worthy of all the attention they can receive from enlightened and philanthropic citizens. It is matter of wonder that they have not hitherto gained that hold on the public mind to which they are entitled; and no less a matter of satisfaction, that they are now to receive notice in a city where there are so many advantages of location, scenery, knowledge, and taste, for their elucidation, combined with right notions of economy, and of all the means of individual and social well being.

But my object in thus taking the liberty to address you, is to suggest, on presumption that you take a part in the proceedings of the association, that the inquiries to be pursued should be extended to some other topics, not less essential to the main design than those which have been announced; or rather that they should commence at an earlier point, and embrace what relates to the kinds of soil on which human habitations ought to be erected, and the choice of localities for that purpose considered in relation to neighboring formations and objects.

Without pretending to do more than to glance at some of the most obvious heads of inquiry under this branch of the subject, I may illustrate what I have in view, by a brief statement of questions which require investigation.

1. What are the chief requisites in a site for a dwelling house?

What circumstances and advantages are desirable, considered simply in relation to the principal design and use of the building; and what, considered in relation to adjacent objects?

2. What descriptions of soil are proper for the sites of dwellings?

What soils are to be preferred for yards, gardens, and adjoining grounds?

What soils are objectionable on account of their natural composition, or their liability to excessive moisture, or other vicissitudes?

3. What kinds of earth are to be preferred for cellars, considered in respect to moisture, temperature, and effects, in different seasons, on vegetable substances, and on the air in the apartments above?

4. What objects in the vicinity are in all cases to be avoided? Among these may be specified:

Marshes and all permanent receptacles of decaying vegetable matter.

Grounds which are periodically overflowed.

Grounds which are excessively wet from ordinary rains during a portion of every year, and which exhibit extensive evaporation.

Ponds which are drained in the course of the summer or autumn; and other

Localities which are occasionally subject to great changes in their condition, and in their influence on the atmosphere.

5. What considerations are to be taken into view in the choice of sites in given cases, as of plains, valleys, hills, mountains, banks of rivers, exposure to winds and storms, particular geological formations?

6. What considerations are to be regarded, in given cases, respecting the depths of cellars, the elevation of the first floor from the level of the adjacent grounds, and the position, height, and form of houses, reference being had to the position of other dwellings, and to that of out-buildings, gardens, roads, streets, and distant scenery, and to exposure to winds, storms, cold, and heat?

7. What, with relation to dwellings and to each other, should be the position of barns and other out-buildings?

8. What cautions ought to be observed in the location and construction of dwellings and out-houses, to guard each and all of them against the hazard of fire?

9. What plans and measures are to be adopted respecting door-yards, courts, gardens, shrubbery, vines, and trees?

10. What is to be aimed at in respect to water for household use, and in what cases are pumps or aqueducts to be preferred to wells and fountains?

11. What plans and materials for fences are to be preferred?

12. What plans and materials are most eligible for walks, intended to be dry, durable, and tasteful?

These, and the like heads of inquiry, would give scope for the most valuable instruction and advice, applicable to every part of our country, and which would, one cannot doubt, be extensively well received, adopted, and carried into practical effect.

Of the thousands and tens of thousands who every year engage in the erection of dwellings, how few possess or are in any condition to obtain the knowledge which is needful to guide their judgments in respect to the most essential of the above particulars, or with a view either to economy, conve-

* Many other objects were embraced in the plan.—[Ed.]

nience, durability, elegance, health, security from fire, effect on price, or any other advantage, private or public? In how many thousands of instances, even in localities which present, to an informed and observant eye, unobjectionable sites, are all these benefits lost, and great inconveniences and evils incurred for want of such hints and advices as might be comprised in a tract of a few pages? In numerous cases, both of single dwellings and of neighborhoods, it would seem that no one of these advantages could have been so much as aimed at, or taken into account; and what is, perhaps, somewhat more surprising, when a site has once been chosen and occupied, the most painful experience of its evils, the loss of health and of life itself, seldom causes it to be abandoned.

These observations might be illustrated by reference to insulated houses and to villages, and even cities. The public mind is not impressed with the considerations which ought to be had in view in the location of habitations; and in numberless cases, individuals blindly follow bad examples, or are determined by some whim, or some circumstance foreign to the real and permanent benefits, to secure which ought to be their object. Each one, especially in the country and new settlements, builds his house when, how, and where he pleases, as though his successors and the public had no concern with the matter, and as though the erection of a shelter for his family, in a position and by a process which should least interfere with his present convenience and employments, were all that behoved him to take into account.

Hence it is common to observe houses placed where they should not be, though in the immediate vicinity of eligible sites, while the barns and out-buildings are so near to them and to each other, as to be objectionable on many accounts, besides being all liable to be destroyed by fire in case of the burning of either of them. Houses are likewise frequently built in low and damp situations, where draining is impracticable, while the barns pertaining to them are placed where the dwellings should be, on dry and advantageous locations. In numerous instances, likewise, houses are to be observed, not only on the borders of ponds and marshes, but on the side of them which is opposite to that whence the prevailing wind proceeds.

It were easy to multiply references of this kind; but the subject demands more particular and thorough investigation, and it is of such general concernment that I should suppose the association, besides extending its field of inquiry, might well enlarge its plan in another respect, so as to procure corresponding members, or associations, in different parts of the country and of the world, to co-operate with the primary body, and to publish in your excellent Journal, and in the form of occasional tracts or otherwise, with drawings or cuts, the facts, principles, and advices, which such a combination of means would furnish, and which are so universally needed.

Such an association, branching itself out, and engaging the attention of numerous individuals, might exert a most salutary and effective influence, directly upon the subjects to be treated of, and through them on the health and enjoyments, and indeed on all the personal and social interests of man. That influence would be important in its connection with our moral and political economy, would essentially aid other reformations, would augment the resources of domestic interest and recreation, promote a taste for rural scenery and a love of excellence in every thing, add to the cheerfulness and beauty of dwellings, and prompt to the cultivation of the minds and hearts of their inmates. The bearing of such an influence on the subject of temperance, in very numerous instances of dwellings placed in unhealthy situations, is sufficiently obvious; and likewise its tendency to prevent indolence, pauperism and vice, and consequently to diminish the hazards and burdens which one portion of every community imposes on another and better portion. He who is neat and tasteful in and around his dwelling, will be likely to cultivate those qualities of mind and heart which such a state of things implies and requires; and will promote the same associations and habits in his family, and extend them to the literary, moral, and social education and conduct of his children. A portion of such families in each small community would, by their sentiments and example, raise the general standard of opinion and taste, and exalt these arrangements of elegance and comfort into rules of social observance, and requirements of decent propriety.

No such reformation, however, of the opinions, tastes, and habits of mankind, is to be hoped from individual or insulated effort. Reason and argument in such a case will be ineffectual, unless combined with personal and local influence. The threefold cord of association is the indispensable and only adequate instrument of success in an undertaking of this nature; and for the same reasons, even this instrument must be present and locally operative in every vicinage and community where its beneficial results are to be expected.

Nor is the design capable of being so easily or speedily accomplished in any way, as to render unnecessary an extensive organization. Though many of the most important suggestions to be made require no very labored investigation, and, among those who comprehend them, scarcely admit of two opinions; yet there are questions to be resolved respecting the location and structure of dwellings, almost as numerous as the varieties in the surface of the earth, and the wrong notions and habits of those who occupy it—questions which demand extensive inquiry and observation, and which will not be exhausted while any thing remains unknown of earth or air injurious to human health and happiness. The subject involves the physical nature, circumstances, and wants, of man, and in no slight degree his welfare as a rational, social, and accountable being; it has an important relation to his plans, employments, and success in life, and, indeed, to his whole history; it is to be studied in all its relations to nature and art, its relations to what is uniform and unalterable in the earth, to the various changes which are taking place in the surface, to various local peculiarities, to the increase and decay of vegetable matter, and the neglect or progress of cultivation, to changes in the course and deposits of streams, to the condition of natural and artificial collections of water, to climate, and to the long catalogue of local, periodical, and epidemic diseases.

A general reformation of the opinions and tastes of mankind, in respect to this whole subject, is greatly to be desired as a means of temporal happiness. No small proportion of the self-procured and the hereditary misery and degeneracy of the race, proceeds from ignorance and neglect of what is every where practicable in relation to this subject.

Who that closely inspects the sites, plans, materials, and condition, of all the habitations in any district of country, or in any town or city, and the character, habits, pecuniary circumstances, pursuits, recreations, and enjoyments, of their respective occupations, but must be forcibly struck with the powerful and discriminating effects of the causes which are involved in this field of inquiry? Who that traces the progress of an individual from his infancy in a mean, filthy, and ill situated abode, to one that is desirable for its location, structure, and other advantages, can fail to perceive the operation of these causes?

Of how many, both of the best and worst members of society, may it not be said, that the influence of such causes on their natural dispositions and tastes, determined their course above or below the level on which they started? I remember an anecdote, related to me by the late Rev. Dr. Strong, of his ancient preceptor, Dr. Bellamy, who, on parting with two of his pupils, by way of caution and advice to them, indicated, as what he had dreamed, his impressions, founded, no doubt, on what he had observed of their capacities, tastes, and habits, respecting their future career. The rising progress of one he traced to a thriving and beautiful parish, a handsome and commodious dwelling, and subsequent usefulness and honor. The other he followed from one thriftless and quarrelsome parish to another, till he reached the poorest and most desolate section of New-England. He afterwards visited the first at his residence in Hartford, and the other in a wretched tenement, surrounded by ragged children, in a parish which could boast only of such a minister, with no meeting-house, no school, and scarce a single entire glass window.

But there are other and far more important consequences to be looked for, than those which relate merely to temporal comfort and prosperity: consequences which involve the intellectual and immortal interests of men. And in that improved and cultivated state of society which the scriptures teach us to expect, when the present causes and occasions of degradation and sorrow will be resisted and overcome, when the evils we endure will be obviated by the Divine blessing on a wise and proper exertion of our faculties, this reformation will be universal and complete.

There is, then, every encouragement of growing and ultimate success to cheer those whose part it is to promote this object. And there surely are not wanting those in every place who by their education and circumstances are qualified to take a part in it, and who by a common effort may soon do much for its advancement.

Let such fancy to themselves a town or village in a location free from all material objections, and possessing every essential advantage, and laid out and built in such a manner as to secure all the objects, public and private, which are desirable; let it be supposed that the benefits of such an arrangement are appreciated by the inhabitants, and that they agree in their tastes and opinions on this subject; and can there be any more doubt of the good effect of such a state of things on all the interests, character, and welfare of the families concerned, than of the actual difference between the worst

and best sites, buildings, and occupants, in towns as they now exist?

Let them also consider what evils might be easily obviated, and what benefits secured, in their own immediate neighborhoods, by the improvements which attention to this subject would suggest; and to what more useful or creditable purpose their talents, knowledge, and leisure, can be applied.

The subject may fitly be commended to the attention of lyceums and other existing institutions in different parts of the country, with particular reference to their respective localities.

With great regard, I remain your obedient servant, ELEAZAR LORD.

DR. JEFFREY'S APHORISMS.—Let the day begin with God—that the peaceful influence of communion with him may calm the hurried and tumultuous action of the body, in the performance of its daily avocations.

Let the early fast be broken by no more food than will defend the body from severe exhaustion, in the labor or pursuit which is to follow.

Let the exercise or labor which is performed be in faithful accordance with the injunction, that the food should be earned by the sweat of the brow.

Let the principal food taken be at a time when it shall repair the parts and powers which have been consumed by previous exertion of body, or of mind, rather than in anticipation of such decay or waste; so that the body shall not suffer from the increased effort of severe digestion, while it is pushed to labor: and the mind may not be cramped in its energies by a crowded system.

Let the sleep be regularly taken, and religiously observed to such extent as shall restore the nervous energy of the frame; but let not the bed rob God or man of the service of one hour which belongs to them. To this end, seek rather to ascertain by experience how little will fully suffice the requirements of the system, than how much it can safely bear.

Let the clothing be designed to cover, rather than to adorn the person; and let it be only so much in quantity as will defend the body from inclemency, and not to such extent as will enfeeble its powers. Seek rather to inure the body to climate, than to defend it entirely from the influence of cold or heat.

Let the person be kept sacredly clean, lest the body become infected from the want of ablution, or the mind become defiled by the consciousness of an impure temple: for

> 'Even from the body's purity, the mind
> Receives a secret sympathetic aid.'

Let a holy chastity mark the conduct and the conversation in every relation of life—lest the frame should become enervated from undue bodily or mental excitement.—[American Quarterly Observer.]

SUDDEN EFFECTS OF THE MIND UPON THE BODY.—Plato used to say that all the diseases of the body proceed from the soul. Says Mr. Weld, in his famous report,—The expression of the countenance is mind invisible. Bad news weakens the action of the heart, destroys appetite, oppresses the lungs, stops digestion, and partially suspends all the functions of the system. An emotion of shame flushes the face, fear blanches it, joy illuminates it; an instant thrill electrifies a million nerves. Surprise spurs the pulse into a gallop. Delirium infuses giant energy, volution commands and hundreds of muscles spring to execute. Powerful emotion often kills the body at a stroke. The news of a defeat killed Philip V. One of the Popes died of an emotion on seeing his pet monkey robed in pontificals and occupying the chair of state. Muley Moloch was carried upon the field of battle in the last stages of incurable disease; upon seeing his army give way, he leaped from the litter, rallied his panic-stricken troops, rolled back the tide of battle, shouted victory, and died. The door-keeper of the Congress of the United States expired upon hearing the surrender of Cornwallis. Eminent public speakers have often died, either in the midst of an impassioned burst of eloquence, or when the deep emotion to produce it had suddenly subsided. The recent case of Hills, in this city, is fresh in the memory of all. He was apprehended on a charge of stealing goods from his employer, and taken before the police; though in perfect health, mental agony forced the blood from his nostrils—he was carried out, and died.

BALD EAGLE.—Dr. Franklin's character of the Bald Eagle, and his preference of the Turkey as the national blazon:

"For my own part I wish the Bald Eagle had not been chosen as the representative of our country: he is a bird of bad moral character; he does not get his living honestly; you may have seen him perched on some dead tree, where, too lazy to fish for himself, he watches the labors of the fishing hawk, and when that diligent bird has at length taken a fish, and is bearing it to his nest for the support of his mate and young ones, the bald eagle pursues and takes it from him. With all this injustice he is never in good case, but, like those among men who live by sharping

and robbing, he is generally poor and very lousy. Besides, he is a rank coward; the little king-bird, not bigger than a sparrow, attacks him boldly, and drives him out of the district. He is therefore by no means a proper emblem for the brave and honest Cincinnati of America, who have driven all the king-birds from our country; though exactly fit for that order of knights whom the French call *chevaliers d'industrie*. I am on this account not displeased that the figure is not known as the bald eagle, but looks more like a turkey. For in truth, the turkey is, in comparison, a much more respectable bird, and withal a true original native of America. Eagles have been found in all countries, but the turkey was peculiar to ours. He is, besides, (though a little vain and silly, 'tis true, but not the worse emblem for that,) a bird of courage, and would not hesitate to attack a grenadier of the British Guards, who should presume to invade his farm-yard with a red coat on."

It is said that you cannot pluck, even by scalding, the feathers from the bald eagle. —[Westminster Review.]

On the Causes of Spontaneous Combustion. By J. A. B. [From the Journal of the Franklin Institute.]

I wish, through the medium of your Journal, to solicit the attention of some of your scientific readers to the causes of spontaneous combustion, generally; and with a view particularly to the investigation of those causes that are liable to produce it in cotton, woollen, and paper factories, from the stock, or waste, being accidentally impregnated with oils, or other substances.

As very few manufacturers are sufficiently acquainted with chemistry to determine accurately the causes of the effects which they may observe, it is therefore desirable that men of science, who have leisure, inclination, and information, (our correspondent has forgotten an important item, viz. *means*,) adequate to the task, should undertake and perform a series of experiments on the intermixture, or chemical combination, of different materials, together with the proportions, situations, degrees of heat, &c., requisite, in each case, to produce spontaneous combustion, and that publicity should be given to the same through the pages of this Journal.

The vast amount of capital invested in various kinds of manufactures, and the large number of mechanics and workmen of every grade and description, who are interested, either directly or indirectly, in the safety and prosperity of our factories, whose daily support and almost sole means of accumulating property are derived from their employment therein, all unite in the requisition.

It is confidently believed that many buildings have been destroyed by fire, originating in spontaneous combustion, and that there is frequently great danger, where it is least suspected.

To aid in the inquiry, agents and superintendents, as well as the observers in the several departments of factories, should unite in communicating such cases as may have come within their notice, together with such facts and circumstances as attended them.

To contribute my mite, I will give an account of the few instances that are within my knowledge, although my statements cannot be as detailed as I could wish, from my not having paid much attention to the subject at the time the observations were made.

The first instance of spontaneous combustion, or that which was apparently so, and was not otherwise accounted for, was in a quantity of wood ashes.

The ashes were in the body of an old waggon, with boards above, at the sides and ends, and had been accumulating for more than two years, to the amount of fifty bushels, or more. The ashes belonged to a very careful man, if the epithet is not altogether inapplicable to a person who would deposit ashes in a wooden vessel, whose constant custom was to have his ashes taken up from the hearth in a metallic vessel, and stand therein until entirely cold, before they were put into the usual place of deposit, and no danger was apprehended from this practice.

One evening about sunset, smoke was perceived to issue from the body of ashes, and it was first supposed that one of the domestics had, contrary to strict orders, put in some hot embers; but, on inquiry, it did not appear that any ashes had been added for three days, and this appeared the more probable, as several vessels were then found standing full of ashes which had been taken up.

When the fire was discovered, it was expected that it was confined to a small spot only, and that a small quantity of water would be sufficient to extinguish it, but, on pouring water on the mass, the ashes were scattered very extensively, and on further examination it was found that the boards in several places were burnt almost through, and that the whole quantity of ashes was in a state of ignition like embers immediately from the fire. Nothing but a timely discovery prevented the destruction of a large portion of a village, for the buildings were all of wood, and so situated that the chance of

saving one out of twenty would have been but very small.

I should be glad to throw some further light on this subject, but every thing else in relation to it was mere conjecture, and whether some oily substance was accidentally intermixed with the ashes, or was introduced by carelessness, or otherwise, or from what cause the combustion was produced, remains entirely unknown.

Instances have been known in which cotton has taken fire by wiping up with it oil that had been spilled, both linseed and sperm oil.

Weavers' harnesses in factories are varnished with a varnish made of the following materials, the same, in greater or less proportions, being used by different manufacturers: the usual ingredients are, linseed oil, spirits of turpentime, litharge, red lead, shellac, umber and India rubber. The composition is boiled down to a thick varnish, or laid on to the harness with a brush. The harness is usually made of cotton twine.

I once knew an instance in which a hank of twine, which was varnished for mending harness, took fire, spontaneously, while hanging to dry.

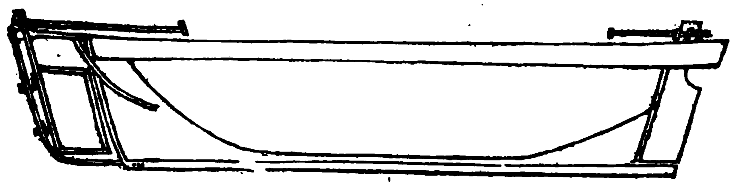
I mention this circumstance, because in many factories it is customary to varnish and hang the new harness to dry in the garret, or some other spare room of the mill, and likewise to lay away the old worn-out harness in the same place, and with very little caution as to the quantity that comes in contact: a practice that may lead to dangerous and destructive consequences.

I hope my remarks will not be considered irrelevant. It will readily be perceived that my object is, at this time, more to obtain than to communicate useful information.

Very respectfully, yours,

J. A. B.

Pittsfield, N. H., December 2, 1833.



A Bow Rudder. By W. Aldersey. [From the United Service Journal.]

The following plan is proposed for fixing and working a rudder at the bow of a vessel, to act in unison with the rudder at the stern, as calculated to embrace all the advantages proposed by that experienced and highly respectable officer in the East India Company's service, Capt. William Manning, as stated in p. 541 of the United Service Journal for December, 1831; and which, I think, will also be found to meet the objections of W. J. T. of Cambridge, page 260, in the number for October, 1832.

The plan consists in fixing an additional stem, made of iron, of sufficient strength, on the present stem of the vessel (already built), and securing the same by strong braces fixed securely on the bow, and hanging the rudder on the additional stem at the bow, precisely in the same way as the rudder at the stern is hung, as shown in the drawing.

The following results may be expected: 1st, The rudder at the stem is intended to act in unison with the rudder at the stern, by which means the same force would be exerted at each end of the vessel, and would unite in effect to bring the vessel round to the wind, and prevent her missing stays; 2d, When before the wind, or nearly so, the rudder on the stem might be allowed to swing, or be fixed, as thought necessary; 3d, When the tiller at the stem is put a little to leeward, and the rudder at the stern is made to act in unison with it, their combined influence would very much tend to keep the vessel to windward; 4th, The rudder at the stem would be an additional security in case of accident to the rudder at the stern, to which it is liable from going over a bar, and from other causes; 5th, The additional rudder at the stem appears particularly suitable for steam vessels, by which means the steersman at the bow would have it in his power to discover, and instantly avoid, every impediment in the ship's course; and would be particularly useful at night, and in foggy and boisterous weather, and in rivers crowded with vessels, both moving and stationary.

In the drawing, the keel is lengthened to the extremity of the foot of the rudder, to show an easy and safe mode of protecting it from accident, when the ship touches the ground at the stern. In building a new vessel, the keel may be carried out, in the first instance, of sufficient length to have the additional stem built in the frame of the vessel to receive the bow rudder; and the tiller

may be made in any form, and applied in any way, most convenient.

Mechanics' Wives.—Speaking of the middle ranks of life, a good writer observes:

"There we behold woman in all her glory: not a doll to carry silks and jewels, not a poppet to be flattered by profane adoration, reverenced to-day, discarded to-morrow; always jostled out of the place which nature and society would assign her, by sensuality or by contempt; admired, but not respected; desired, but not esteemed; ruling by passion, not affection; imparting her weakness, not her constancy, to the sex she would exalt; the source and mirror of vanity. We see her as a wife partaking the cares and cheering the anxiety of a husband, dividing his toils by her domestic diligence, spreading cheerfulness around her; for his sake sharing the decent refinements of the world, without being vain of them; placing all her joys and her happiness in the man she loves. As a mother, we find her the affectionate, the ardent instructress of the children whom she has tended from their infancy; training them up to thought and virtue, to piety and benevolence; addressing them as rational beings; and preparing them to become men and women in turn. Mechanics' daughters make the best wives in the world."

Lessons on Health.—*Occupations which are unhealthy.*—Coffee roasters become asthmatic, and subject to head-ache and indigestion. Malsters (persons who prepare malt,) cannot live long, if they continue in the business. Snuff-making is unhealthy. Tea men suffer from the dust, especially of green teas. Brewers are apt to be unhealthy. Distillers are liable both to acute and chronic diseases. Chimney sweeps die early. House painters do not usually live to old age. Confectioners are by no means among the longest lived. Cooks are unhealthy; probably because they are apt to eat between meals, and eat up things to save them! Chemists and druggists are sickly and consumptive. Miners die young. Printers frequently complain of the stomach and head, but many are healthy. Engravers are sickly. Tailors, ropemakers, and shoemakers, usually suffer from their stooping postures. Milliners, dress makers, and straw-bonnet makers, are unhealthy and short lived. Watchmakers are sickly. Colliers, well sinkers, corn millers, paper makers, masons (these generally die by 40 or 50), iron filers, brass founders, copper smiths, tin plate makers, potters, plumbers, saddlers, and glass-blowers, are usually unhealthy. Butchers appear healthy, but they do not often live to old age.

Those which are healthy.—Farmers live long, though gardening is not so healthy, on account of stooping so much. Brickmakers, coopers, carpenters, fishmongers, wheelwrights, tanners, curriers, clockmakers, soap makers, tallow chandlers, dyers, grooms, hostlers, brush makers, men in oil mills, pressmen in printing offices, and bookbinders, are generally healthy.

Animal Weather Glass.—In Germany there will be found, in many country houses, an amusing application of zoological knowledge, for the purpose of prognosticating the weather. Two frogs are kept in a glass jar, about eighteen inches in height, and six in diameter, with the depth of three or four inches of water at the bottom, and a small ladder reaching to the top of the jar. On the approach of the dry weather, the frogs mount the ladder—but when wet weather is expected, they descend into the water. These animals are of a bright green.

Imitation of Gold.—"A Chemist," of Washington City, publishes the following recipe for a preparation, which, applied to iron, will make it look like gold:

"Take of linseed oil, three ounces; tartar, two ounces; yolk of eggs, boiled hard and beaten, two ounces; aloes, half an ounce; saffron, five grains; turmerick, two grains. Boil all these ingredients in an earthen vessel, and with it wash the iron, and it will look like gold. If there be not linseed oil enough you may put in more."

The Press.—[The following lines were written by the author of "Corn Law Rhymes" (a Journeyman Brazier of Sheffield, England,) on occasion of the procession in that town on the passing of the Reform Bill.]

God said, "Let there be light!"
Grim darkness felt his might,
And fled away;
Then startled seas, and mountains cold,
Shone forth all bright in blue and gold,
And cried—"'Tis day, 'tis day!"

"Hail, holy light!" exclaimed
The thunderous cloud, that flamed
O'er daisies white;
And lo! the rose in crimson dress'd,
Lean'd sweetly on the lily's breast,
And blushing, murmur'd, "Light!"

Then was the sky-lark born,—
Then rose the embattled corn,—
Then streams of praise
Flow'd o'er the sunny hills of noon;
And when night came, the pallid moon
Pour'd forth her pensive lays!

Lo, heaven's bright bow is glad!
Lo, trees and flowers, all clad
In glory, bloom!
And shall the mortal sons of God
Be senseless as the trodden clod,
And darker than the tomb?

No! By the mind of man!
By the swart artizan!
By God, our sire!
Our souls have holy light within,
And every form of grief and sin
Shall see and feel its fire.

By earth, and hell, and heaven!
The shroud of souls is riven!
Mind—mind alone
Is light, and hope, and life, and power:
Earth's deepest night, from this bless'd hour,
The night of minds, is gone!

The second Ark we bring—
"The Press!" all nations sing:
What can they less?
Oh, pallid want! oh, labor stark!
Behold, we bring the second ark—
The Press!—the Press!—the Press!

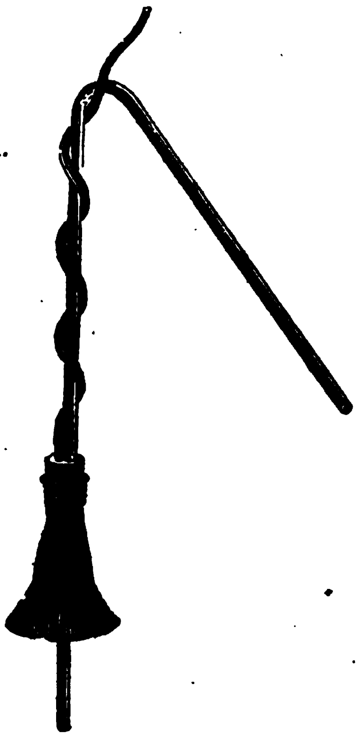


Fig. 1.

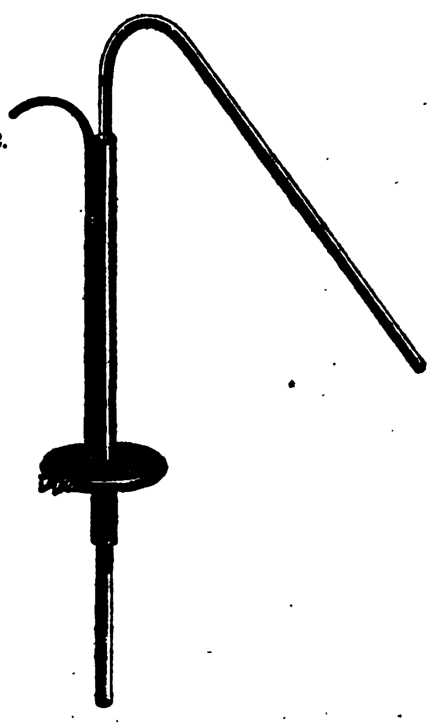


Fig. 2.

Improved Syphons. By R. Hare, M. D., Professor of Chemistry in the University of Pennsylvania. [Communicated by the Author.]

Annexed are engravings of two syphons, which I have found useful in my laboratory. Of these, one represents the more complete method of execution; the other, that which can be more easily resorted to by chemists in general, who have no easy access to skilful workmen.

The construction last alluded to is represented by fig. 1. A cork is perforated in two places parallel to the axis. Through one of the perforations the longer leg of the syphon passes; into the other, one end of a small lead tube is inserted. In order to support this tube, it is wound about the syphon until it approaches the summit, where a portion, of about three or four inches in length, is left free, so that advantage may be taken of its flexibility to bend it into a situation convenient for applying the lips to the orifice. About the cork, the neck of a stout gum elastic bag is tied air tight. The joinings of the tubes with the cork must also be air tight. The lower half of the gum elastic bag is removed, as represented.

In order to put this syphon into operation, a bottle must be used, having a neck and mouth of such dimensions as to form an air tight juncture with the bag when pressed into it. This object being accomplished, the air must be inhaled from the bottle until the diminution of pressure causes the liquid to come over and fill the syphon. After this, on releasing the neck of the bottle, the current continues, as when established in any other way.

Fig. 2 represents the more complete construction. In this are two metal tubes, passing through perforations made for them in a brass disc, turned quite true. Through one of these tubes, which is by much the larger, the syphon passes, and is cemented air tight. The other answers the purpose of the leaden tube described in the preceding article. The brass disc is covered by a piece of gum elastic, which may be obtained by dividing a bag of proper dimensions. The covering thus procured is kept in its place by a brass band or clasp, made to embrace both it and the circumference of the plate, and to fasten by means of a screw.

Before applying the caoutchouc, it was softened by soaking it in ether, and a hole, obviously necessary, was made in the centre by a hollow punch.

There is no difference between operating with this syphon, and that described in the preceding article, excepting that the juncture of the syphon with the bottle is effected by pressing the orifice of the latter against the disc covered with gum elastic.

Apparatus contrived by Dr. Hare for separating Carbonic Oxide from Carbonic Acid, by means of Lime Water. [Communicated by the Author.]

Lime water being introduced in sufficient quantity into the inverted bell glass, another smaller bell glass, C, is supported within it, as represented in this figure. Both of the bells have perforated necks. The inverted bell is furnished with a brass cap, having a stuffing-box attached to it, through which the tube D, of copper, slides air-tight. About the lower end of this tube, the neck of the gum elastic bag is tied. The neck of the other bell is furnished with a cap and cock, surmounted by a gallows screw, by means of which a lead pipe, P P, with brass knob at the end suitably perforated, may be fastened to it, or removed at any moment. Suppose this pipe, by aid of another brass knob at the other extremity, to be attached to the perforated neck of a very tall bell glass filled with water upon a shelf of the pneumatic cistern, on opening a communication between the bells, the water will subside in the tall bell glass, over the cistern, and the air of the bell glass, C, being drawn into it, the lime water will rise into and occupy the whole of the space within the latter. As soon as this is effected, the cocks must be closed, and the tall bell glass replaced by a small one filled with water, and furnished with a gallows screw and cock. This bell being attached to the knob of the lead pipe, to which the tall bell had been fastened before, the apparatus is ready for use. I have employed it in the new process for obtaining carbonic oxide from oxalic

acid, by distillation with sulphuric acid in a glass retort. The gaseous product consists of equal volumes of carbonic oxide and carbonic acid, which being received in a bell glass, communicating as above described by a pipe with the bell glass C, may be transferred into the latter, through the pipe, by opening the cocks. As the gaseous mixture enters the bell C, the lime water subsides. As soon as a sufficient quantity of the gas has entered, the gaseous mixture may, by means of the gum elastic bag and the hand, be subjected to repeated jets of lime water, and thus depurated of all the carbonic acid. By raising the water in the outer bell, A, the purified carbonic oxide may be propelled, through the cock and lead pipe, into any vessel to which it may be desirable to have it transferred.

A Compendium of Civil Architecture, arranged in Questions and Answers, with Notes, embracing History, the Classics, and the Early Arts, &c. By Robert Brindley, Architect, Surveyor, and Engineer. [Continued from Vol. II., page 195.]

INDIAN.

Q. What is the character of the ancient Indian architecture?

A. It is closely connected with the Egyptian, consisting principally in excavations. The most remarkable temple is found in the island of *Elephanta*, so called from an elephant of black stone, the size of life, being near the landing place.

Q. Of what description is this temple?

A. This temple is elevated, being wrought in a hill; it forms a square of 130 feet, and the interior height is 14½ feet; the roof is supported by columns in ranges; and upon the walls gigantic figures are sculptured; the columns are similar to those of Egypt, and the capitals flat, like cushions.

Q. What other temple is there?

A. One in the Island of Salsette. The excavation describes a square of 28 feet, approached by a long walk; at the end of which is the outer door-way, 20 feet high, opening into the vestibule, and passing from thence, by an inner door, into the temple. Figures are sculptured on each side of the door. The roof is supported by 20 columns 14 feet high, like those of Elephanta.

Q. Are there any other buildings?

A. Yes. The excavations of Ellora, at Canarah, and other places, are of similar character.

PERSIAN.

Q. What of Persian architecture?

A. The ancient ruins of Persia indicate many superior attainments in the art.

Q. Where are the most distinguished?

A. In the once celebrated city of Persepolis, now *Estakar* or *Tehel Minar*, are the relics of the magnificent palace, which, for a long time, comprised 40 pillars or columns, denominated by the inhabitants "*Chehul Minar*," i. e. a place of 40 pillars. The adhesion of the stones in this fabric is effected by cramps, and not cement, many traces of which remain.

Q. What is the character of these ruins?

A. There is a resemblance in them to those of Egypt; yet a distinction will be found by the adornments sculptured in relief on the building, consonant with the luxurious and pompous disposition of the people. These ruins, astonishing the traveller by their grand appearance, are now the habitations of birds and beasts of prey. Several inscriptions in Arabic, Persian, and Greek, are still preserved.

PHŒNICIAN.

Q. What may be advanced on Phœnician architecture?

A. Possessing the arts of civilization, at a remote period, the Phœnicians had several large cities, famous for riches, manufactures, and commerce: Sidon, Tyre, Joppa, Damascus, and Baalbic, substantiate the prowess of this nation, which is supposed to be the same as the "Land of Canaan," spoken of in Holy Writ. But of the description of their buildings we have no criterion. Herodotus makes mention of a temple of Hercules at Tyre, as being very superb; and Strabo, speaking of Tyre and Dradus, two isles in the Persian Gulf, adds, "they had temples resembling the Phœnicians;" clearly demonstrating that the Phœnicians had a style of their own.

HEBRAIC.

Q. What were the dwellings of the Hebrews or Israelites?

A. From the roving disposition of these people, their dwellings were those of tents. The tent denominated the Tabernacle, and described in the Bible, was used for a length of time after the conquest of Palestine, A. c. 300.

Q. Did the Jews acquire any civilization in Egypt during their bondage?

A. Yes; and from what they had seen in Egypt, they, after their deliverance, betook themselves to building a temple.

Q. Under whose reign was the temple begun?

A. That of Solomon; the details of which are very much confined in Scripture. The summit of mount Moriah formed a plane of 36,310 square feet; the top was levelled, and a wall built of free-stone 400 cubits

high. The circumference of the mountain at the foot was 3000 cubits; upon this plane was built the temple, divided into two divisions, by a partition of cedar.

Q. What description may be gathered of this temple?

A. In the principal front was the *Ulam*, or grand portico. The windows of the temple were similar to those of Thebes: timbers of cedar, and roof flat, like the Egyptian. Round the temple was a wall; the space between which and the temple was occupied by the porch, divided into three stories. The principal edifice was preceded by two courts: 1st, for the people; 2d, called the Priest's court, was the temple, surrounded with apartments for the priests. Before the Ulam were two pillars of brass, the capitals of which resembled the *Lotus*, found in Egypt, but there were no bases. These were to decorate, as the obelisks before Egyptian temples. The exterior walls of the temple were stone, squared at right angles, ornamented with figures, &c. The roof was covered with plates of gold, and the interior was decorated in the richest manner with draperies.

Q. What character or order of this temple may be defined?

A. Of this temple it is difficult to form any definition. The Phœnician artists most likely were engaged. About 40 years before the dedication of the temple, a colony from the Ionian islands migrated and settled in Asia Minor; and although the arts did not flourish much in Greece for a long period after Solomon, is certain, (since Homer, who was contemporary with Jehosaphat, and whom some chronologists place down so low as Hezekiah, gives no account of columns of stone in all his writings) yet Solomon's pillars, with the chapter, &c. in construction, bear some analogy to those which were afterwards in vogue in the most flourishing period of Greece.

Q. What conclusive opinion may be drawn?

A. That the temple embraced a mixture of order, borrowed from its precursory Egyptian; in which the Ionian and Doric were introduced in their rudest shapes.

Q. Can Solomon's temple be considered as a model of architecture to the whole world?

A. Certainly not. Yet no doubt but imitations have been made from it by different nations, and handed down in various stages, till divided into the definite, yet elaborate Grecian and Roman orders.

CHINESE.

Q. What are the original models of Chinese architecture?

A. Tents and pavilions.

Q. What are the materials employed in building?

A. Different kinds of wood, with bricks and tiles burnt or dried in the sun.

Q. What is the prevailing style of Chinese architecture?

A. Mr. Elmes has observed "that it must be familiar to every one who has drunken from a China cup, or noticed the signs at grocers' shops." An observable point is the abundant use of pillars of wood to support their roofs, with marble or stone bases. When used externally, they support a viranda or outer roof, which being too low for a house, a second roof is constructed, with the peristyle much higher.

Q. What is the governing rule of Chinese architecture?

A. Prescriptive police regulations. Hence the palaces for 1st, 2d, and 3d order of the Imperial family—of a Mandarin or grandee of the empire—the public edifices of the capital, and also of provincial cities or towns, according to their different grades in the empire,—all yield in subserviency, producing the greatest monotony.

Q. For what are the palaces of China remarkable?

A. Their great extent, number of courts, galleries, &c.; in imitation of which is the pavilion at Brighton.

Q. What are the pagodas?

A. Lofty towers, being pile upon pile. An extraordinary one is at Nankin, covered outside with porcelain. A pagoda was erected under Sir W. Chamberlain, in Kew Gardens, in celebration of the proclamation of peace, in 1814.

Q. What are the most gigantic works of China?

A. The construction of a bridge, extending from one summit of a very high mountain to the other, consisting of one span; also, the celebrated wall dividing China from Tartary, being upwards of two thousand miles in length, and so broad that several horsemen can ride abreast of each other on the top. Forty-five thousand towers are said to be erected on the same.

GRECIAN.

Q. What kingdoms were successively founded in Greece?

A. Argos, established under Inacus, A. C. 1856; Athens, under Cecrops, A. C. 1556; and Thebes, Sparta, and others, A. C. 1493.

Q. Define the origin and progress of Grecian architecture, the prototype of which is to be sought in that of the Egyptian?

A. Cadmus, who flourished 1500 years before the Christian era, is said to have in-

troduced the arts and sciences into Greece, about 560 years after the building of the walls of Babylon.

Q. What city did Cadmus build?

A. Thebes, named after the celebrated one in Egypt, and in all probability built under similar arrangements and style of architecture.

Q. Did art shed its beams over these unimportant colonies?

A. Yes; and gradually diffused a taste throughout the colonies, the correctness, simplicity, and elegance, of which have been the models of passing ages.

Q. What might tend to mature the art?

A. The religion of the Greeks, dressed in splendid mythology, contributed abundant subjects for the painter, the sculptor, and the architect. The Lacedemonians embellished their chambers with the most exquisite models of loveliness and symmetry.

Q. What were the first materials used by the Greeks in their sacred buildings?

A. Timber, then brick: the art of making which they learned from the Egyptians: subsequently stone was employed, as in the temple of Apollo, on Mount Lucas, built by Amphyctyon, and ultimately marble.

Q. What methods of construction were introduced?

A. There were three: 1st, *Isodomon*, with courses of equal lengths and thicknesses; 2d, *Pseudisodomon*, admitting different heights, lengths, and thicknesses of the courses; 3d, *Emplecton*, the front stones being only wrought; the inner part filled up with rubble. The last was chiefly employed in rude work, as walls.

Q. Did the Greeks use *cement*?

A. No; the weight of the stone and the nicety with which it was worked precluded the necessity.

Q. What was a distinguishing feature in Grecian architecture?

A. Every ornament introduced was in concord with the peculiar order employed, and also with the character and object of the edifice. The external embellishments were bold, although simple, and never redundant.

Q. How were the pediments of the temples and the metopes of the frieze decorated?

A. With *bassi relievi*; and the angles of the walls with pilasters, such as the temples of Minerva and of Theseus, at Athens, and of Jupiter Panhellenieus at Egina.

Q. Of what figures were the temples?

A. Principally quadrilateral, differing only in size, order of architecture, number of columns, and disposition of porticos.

Q. What order most prevailed in Greece before the Macedonian conquest?

A. The Doric, which also was established in Italy and Sicily.

Q. What added splendor to the Grecian edifices?

A. A serene sky, and a splendid sun shedding his rays on the marble, which reflected the most beautiful golden tinge.

ETRUSCAN.

Q. What of the Etruscan architecture?

A. It stands nearly co-equal with that of Greece, the Etruscans being a colony of Grecians. It is also the parent of the Roman style, with which, at a very early period, it became closely identified with the history of this great people, one of the two orders super-added by the Romans (Tuscan) deriving its name therefrom.

Q. What are its distinguishing marks?

A. The invention of *Atriæ*, or court-yards, in front of houses, first introduced into Atria. This plan was simple, consisting of a parallelogram surrounded by a portico, and supported by rough columns.

Q. Was the arch known to the Etruscans?

A. Yes; and their columns differed from other nations. Vitruvius has honored them with forming a new order.

Q. What surprising specimen of the art have the Etruscans afforded?

A. The tomb of Porsenna, king of Etruria, built by him in the city of Clusium.

ROMAN. A. D. 350.

Q. How did the Romans advance in their buildings?

A. Generally improving on the ruder models which they had adopted from their neighbors (the Tuscans), by their connection with Greece itself.

Q. What is described of the earliest Roman edifices?

A. That they were without columns; the greater part of their temples circular, and covered with cupolas, as those of Romulus, Cybele, Vesta, Mars, and the Sybils.

Q. What ideas did the Romans form of pediments, columns, and cornices?

A. In opposition to the Greeks, who deemed them as principal and necessary component parts, the Romans introduced them as merely extraneous ornaments.

Q. What was the result of this mistaken idea?

A. A source of great inconsistency. Vespasian's Temple of Peace exhibits a vault of ground arches, sustained at the springing of each groin by a single Corinthian column. The Colosseum and Theatre of Marcellus have sundry stories of arcades, whilst the

intermediate piers are adorned with engaged columns.

Q. How did the Romans differ from the Greeks in construction?

A. The principal parts of their temples, including the body and columns, were formed of small bricks or stone, united by strong cement, and cased on every side with marble, which were lavishly adorned. The pilasters and pannels of the second story of the interior of the Pantheon present a specimen of this kind of work, designated by the Italians "*umbratile.*"

Q. In what stupendous undertakings did the Romans excel?

A. The throwing over the immense area of the Pantheon, the pensile vault, and the construction of immense aqueducts, inventions utterly unknown to the Greeks. Triumphal arches, forums, and columns, constitute leading features with the Romans.

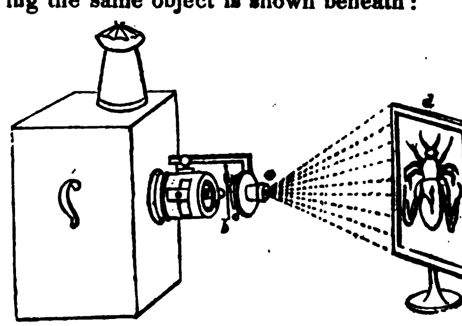
Q. What is the comparison between the rival countries of Greece and Rome?

A. The prominent features of the pure Grecian style are invention, elegance, and strict beauty; yet not destitute of richness. Those of the Romans are a display of splendor, vastness of extent, carelessness of expense, and redundancy of ornaments.

Consumption of Staple Articles in England.—The following is an accurate estimate of the home consumption of England in the great staple articles of commerce and manufactures. Of wheat, 15,000,000 quarters, or 120,000,000 bushels, are annually consumed in Great Britain—this is about a quarter of wheat to each individual; of malt, 26,000,000 bushels are annually used in breweries and distilleries in the United Kingdom, and there are 46,000 acres under cultivation with hops; of the quantity of potatoes and other vegetables consumed we have no accounts; of meat, about 1,250,000 head of cattle, sheep, and pigs, are sold during the year in Smithfield market alone, which is probably about a tenth of the consumption of the whole kingdom; the quantity of tea consumed in the United Kingdom is about 30,000,000 pounds annually; of sugar nearly 4,000,000 cwts., or about 500,000,000 pounds every year, which is a consumption of 20 pounds for every individual, reckoning the population at 25,000,000; and of coffee about 20,000,000 pounds are annually consumed; of soap 114,000,000 pounds are consumed; and of candles about 117,000,000 pounds; of sea-borne coals alone there are about 3,000,000 chaldrons consumed in England and Wales, and it is estimated that, adding the coals of the midland counties, each person of the population consumes a chaldron throughout the kingdom; of clothing we annually manufacture about 200,000,000 pounds of cotton wool, which produces 1,200,000,000 yards of calico, and various other cotton fabrics, and of these we export about a third, so that 800,000,000 yards remain for home consumption, being about 32 yards annually for each person; the woollen manufacture consumes about 30,000,000 pounds of wool; of hides and skins about 50,000,000 are annually tanned and dressed; of paper about 50,000,000 pounds are annually manufactured, which is about 2,000,000 reams of 500 sheets to the ream. —[Farmer's Magazine.]

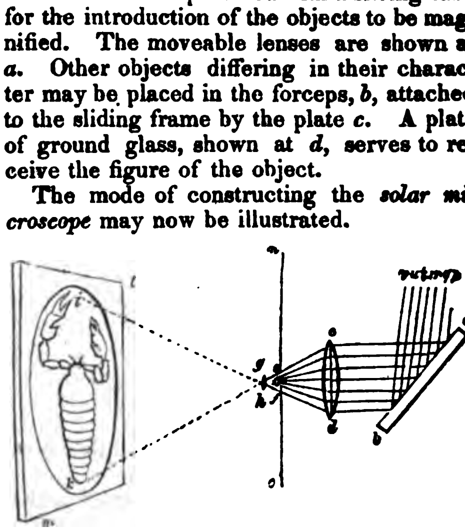
On the Microscope—Method of Constructing, &c. Concluded from page 60. [From Partington's British Cyclopædia.]

Another still more simple mode of effecting the same object is shown beneath:



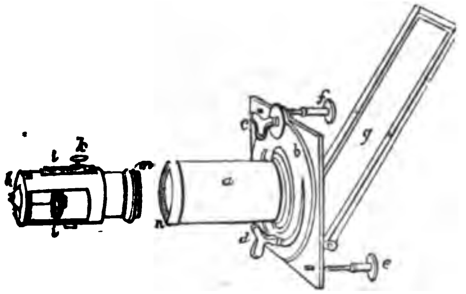
The lantern is provided with a sliding tube for the introduction of the objects to be magnified. The moveable lenses are shown at *a.* Other objects differing in their character may be placed in the forceps, *b,* attached to the sliding frame by the plate *c.* A plate of ground glass, shown at *d,* serves to receive the figure of the object.

The mode of constructing the *solar microscope* may now be illustrated.



It is shown in its simplest form in the above engraving, in which *a b* is the diagonal mirror for receiving the rays of light, *p q r s t u v.* They are reflected by the pol-

ished surface, and thrown on the lens *c d*. Within the focus, at *e f*. is placed any transparent object to be magnified, and the image thus illuminated passes through the lens *g h*. The size of the magnified figure, *i k*, will depend on the distance the instrument is placed from the wall *l m*. The room should be darkened, which is usually effected by employing a large shutter at *n o*. Mr. Baker, speaking of this instrument, says, "that it has conveniences attending it which no other microscope can have: for the weakest eyes may use it without the least straining or fatigue. Numbers of people together may view any object at the same time, and by pointing to the particular parts thereof, and discoursing on what lies before them, may be able better to understand one another, and more likely to find out the truth, than in other microscopes, where they must peep one after another, and perhaps see the object neither in the same light nor in the same position. Those, also, who have no skill in drawing, may by this contrivance easily sketch out the exact figure of any object they have a mind to preserve a picture of, since they need only fasten a paper on the screen, and trace it out thereon, either with a pen or pencil, as it appears before them. It is worth the while of those who are desirous of taking many draughts in this way, to get a frame, in which a sheet of paper may be placed or taken out at pleasure; for, if the paper be single, the image of an object will be seen almost as plainly on the back as on the fore side; and, by standing behind the screen, the shade of the hand will not obstruct the light in drawing, as it must in some degree when one stands before it."



A valuable solar microscope of the most perfect form is represented above.

The square plate *b c d* is attached to the window-shutter by the screws *e f*. The glass plate *g* is mounted in a brass frame, and may be elevated or depressed by a screw at *d*. A rotatory motion is communicated by a pinion and handle at *c*, which acts on a large wheel concealed by the square plate. The first lens is placed in the tube *a*, immediately adjoining the mirror. Another tube *m* is attached by a screw at *n*, and contains two small lenses, and the rack-work, *k l*, for adjusting the focus of the instrument. The objects are introduced at *i*; those best fitted for exhibition are the wings of insects, and the cuttings of wood. When glasses of high power are employed at *h*, they are now constructed on the achromatic principle.

We may now proceed to furnish our readers with some necessary particulars respecting the method of using microscopes. On this, Mr. Adams, in his *Essay on the Microscope*, has been very copious; with a view, as he informs us, to remove the common complaint made by Mr. Baker, "that many of those who purchase microscopes are so little acquainted with their general and extensive usefulness, and so much at a loss for objects to examine by them, that after diverting their friends some few times with what they find in the sliders which generally accompany the instrument, or perhaps with two or three common objects, the microscope is laid aside as of little further value; whereas, no instrument has yet appeared in the world capable of affording so constant, various, and satisfactory an entertainment to the mind."

In using the microscope there are three things necessary to be considered. 1. The preparation and adjustment of the instrument itself. 2. The proper quantity of light, and the best method of adapting it to the object. 3. The method of preparing the objects, so that their texture may be properly understood.

With regard to the microscope itself, the first thing necessary to be examined is, whether the glasses be clean or not: if they are not so, they must be wiped with a piece of soft leather, taking care not to soil them afterwards with the fingers; and, in replacing them, care must be taken not to place them in an oblique direction. We must likewise be careful not to let the breath fall upon the glasses, nor to hold that part of the body of the instrument where the glasses are placed with a warm hand; because the moisture thus expelled by the heat from the metal will condense upon the glass, and prevent the object from being distinctly seen. The object should be brought as near the centre of the field of view as possible, for there only will it be exhibited in the greatest perfection. The eye should be moved up and down from the eye-glass of a compound microscope, till the situation is found where

the largest field and most distinct view of the object are to be had, but every person ought to adjust the microscope to his own eye, and not depend upon the situation it was placed in by another. A small magnifying power should always be begun with, by which means the observer will best obtain an exact idea of the situation and connection of the whole, and will of consequence be less liable to form any erroneous opinion, when the parts are viewed separately by a lens of greater power. Objects should also be examined first in their most natural position; for, if this be not attended to, we shall be apt to form very erroneous ideas of the structure of the whole, as well as of the connection and use of the parts. A living animal ought to be as little hurt or discomposed as possible. From viewing an object properly we may acquire a knowledge of its nature; but this cannot be done without an extensive knowledge of the subject, much patience and many experiments; as in a great number of cases the images will resemble each other, though derived from very different substances. Mr. Baker, therefore, advises us not to form an opinion too suddenly after viewing a microscopical object; nor to draw our inferences till after repeated experiment and examinations of the objects in many different lights and positions; to pass no judgment upon things extended by force, or contracted by dryness, or in any manner out of a natural state, without making suitable allowances. The true color of objects cannot be properly determined by very great magnifiers; for, as the pores and interstices of an object are enlarged according to the magnifying power of the glasses made use of, the component particles of its substance will appear separated many thousand times further asunder than they do to the naked eye: hence the reflection of the light from these particles will be very different, and exhibit different colors. It is likewise somewhat difficult to observe opaque objects; and as the apertures of the larger magnifiers are but small, they are not proper for the purpose. If an object be so very opaque that no light will pass through it, as much as possible must be thrown upon the upper surface of it. Some consideration is likewise necessary in forming a judgment of the motion of living creatures, or even of fluids, when seen through the microscope; for, as the moving body, and the space wherein it moves, are magnified, the motion will also be increased.

On the management of the light depends, in a great measure, the distinctness of the vision; and as, in order to have this in the greatest perfection, we must adapt the quantity of light to the nature of the object, and the focus of the magnifier, it is therefore necessary to view it in various degrees of light. In some objects it is difficult to distinguish between a prominence and a depression, a shadow and a black stain; or between a reflection of light and whiteness, which is particularly observable in the eye of the libella, and other flies, all of these appearing very different in one position from what they do in another. The brightness of an object likewise depends on the quantity of light, the distinctness of vision, and on regulating the quantity to the object; for one will be in a manner lost in a quantity of light scarcely sufficient to render another visible.

There are various ways in which a strong light may be thrown upon objects, as by means of the sun and a convex lens. For this purpose the microscope is to be placed about three feet from a southern window; then take a deep convex lens, mounted on a semi-circle and stand, so that its position may easily be varied; place this lens between the object and the window, so that it may collect a considerable number of rays, and refract them on the object or the mirror of the microscope. If the light thus collected from the sun be too powerful, it may be lessened by placing a piece of oiled paper, or a piece of glass slightly ground, between the object and lens. Thus a proper degree of light may be obtained, and diffused equally over the surface of an object, a circumstance which ought to be particularly attended to; for if the light be thrown irregularly upon it, no distinct view can be obtained.

On account of the sun's motion, and the variable state of the atmosphere, solar observations are rendered both tedious and inconvenient, so that it may be advisable for the observer to be furnished with a large tin lantern, formed something like the common magic lantern, capable of containing an argand lamp. There ought to be an aperture in the front of the lantern, which may be moved up and down, and be capable of holding a lens, by which means a pleasant and uniform as well as strong light may easily be obtained. The lamp should likewise move on a rod, so that it may be easily raised or depressed. A weak light is best fitted for viewing many transparent objects, among which we may reckon the prepared eyes of flies, as well as the animalculæ in fluids. The quantity of light from a lamp or candle may be lessened by removing the microscope to a greater distance from them, or by diminishing the strength of the light

which falls upon the objects. This may very conveniently be done by pieces of black paper with circular apertures of different sizes, and placing a larger or smaller one upon the reflecting mirror, as occasion may require. The light of a lamp or candle is generally better for viewing microscopic objects than day-light, it being more easy to modify the former than the latter, and to throw it upon the object with different degrees of intensity.

With regard to the preparation of objects, Swammerdam has, in that respect, excelled almost all other investigators who either preceded or have succeeded him. He was so assiduous and indefatigable, that neither difficulty nor disappointment could make the least impression on him; and he never abandoned the pursuit of any object until he had obtained a satisfactory acquaintance with it. Unfortunately, however, the methods he made use of in preparing his objects for the microscope are now entirely unknown.

For dissecting *small insects*, Swammerdam had a brass table, to which were attached two brass arms, moveable at pleasure. The upper part of each of these vertical arms was constructed in such a manner as to have a slow vertical motion, by which means the operator could readily alter their height. One of these arms was to hold the minute objects, and the other to apply the microscope.

The lenses of Swammerdam's microscopes were of various sizes as well as foci. His observations were always begun with the smallest magnifiers, from which he proceeded by progressive steps to the greatest.

The minute scales or feathers which cover the wings of moths or butterflies afford very beautiful objects for the microscope. Those from one part of the wing frequently differ in shape from such as are taken from other parts; and near the thorax, shoulder, and on the fringes of the wings, we generally meet with hair instead of scales. The whole may be brushed off the wing upon a piece of paper, by means of a camel's hair pencil; after which the hairs can be separated, with the assistance of a common magnifying glass.

Great difficulty is experienced in dissecting properly the proboscis of insects, such as that of the gnat, and the experiment must be repeated a great number of times before the structure and situation of the parts can be thoroughly investigated, as the observer will frequently discover in one what he could not in another. The *collector of the bee*, which forms an exceedingly curious object, ought to be carefully washed in spirit of turpentine, by which means it will be freed from the unctuous matter adhering to it; when dry, it is again to be washed with a camel's hair pencil, to disengage and bring forward the small hairs which form part of its microscopic beauty. The best method of preparing the stings of insects, which are in danger of being broken, from their hardness, is to soak the case and the rest of the apparatus for some time in spirit of wine or turpentine; then lay them on a piece of paper, and with a blunt knife draw out the sting, holding the sheath with the nail of the finger, or any other blunt instrument; but great care is necessary to preserve the feelers, which, when cleaned, add much to the beauty of the object. The *beard* of the lepas antifera is to be soaked in clean soft water, frequently brushing it while wet with a camel's hair penctl; after it is dried, the brushing must be repeated with a dry pencil, to disengage and separate the hairs, which are apt to adhere together.

The eyes of insects in general form very beautiful and curious objects. Those of the libellula and other flies, as well as of the lobster, &c. must be cleaned from the blood, &c. after which they should be soaked in water for some days: one or two skins are then to be separated from the eye, which would be otherwise too opaque and confused; but some care is requisite in this operation, for, if the skin be rendered too thin, it is impossible to form a proper idea of the organization of the part. In some substances, however, the organization is such that by altering the texture of the part, we destroy the objects which we wish to observe. Of this sort are the nerves, tendons, and muscular fibres, many of which are viewed to most advantage when floating in some transparent fluid. Thus very few of the muscular fibres can be discovered when we attempt to view them in the open air, though great numbers may be seen if they be placed in water or oil. By viewing the thread of a ligament in this manner we find it composed of a vast number of smooth round threads lying close together. Elastic objects should be pulled or stretched out while they are under the microscope, that the texture and nature of those parts, the figure of which is altered by being thus extended, may be more fully discovered.

To examine bones by the microscope, they should first be viewed as opaque objects; but afterwards, by procuring thin slices of them, they may be viewed as transparent. The sections should be cut in all directions, and well washed and cleaned; and, in some cases, maceration will be useful, or the

bones may be heated to a high temperature, in a clear fire, which will render the bony cells more conspicuous.

On the Improved Art of Boring for Water, as practised in the United States: and as the Foundation of a Water Company in New-York. By John L. Sullivan. [From the American Railroad Journal and Advocate of Internal Improvements.]

The practice of boring for water appears to have been first undertaken from the rational probability of its success; but it was found necessary very much to improve the instruments of the art, on account of the nature of the rock and soil. And, for economy of labor, to devise a mode of applying the power of the steam engine to a machine which raises the chisel and allows its blow by sudden release and fall.

The alluvial soil, in which the operation is often to be carried on more deep than wells could be made, required, to reach the rock, the invention of an iron tube, having the quality of great stiffness, without any considerable projection at the joints, both in order to be forced down by powerful leverage, and to be clear within, for the operations to be carried on through it. Being undermined at the same time that pressure is exerted, it, by successive *lengths*, reaches the rock to be bored into, *through it.* Should there not, as often occurs, have been found abundance of water at the surface thereof, implements to overcome any obstacle in the way have also been contrived.

The tube being entered a little into the rock, and pressed down, makes therewith a tight joint; and thus a perforation to the depth of *seven* hundred feet has in several instances been made. There are, indeed, accidents to which the operation is liable, but there are, also, implements to meet such exigencies; and experience has now rendered their management easy. The bore is generally first two and a half inches diameter; and if more water is required than it affords, or permits, it is enlarged to seven inches, by an instrument called the *reamer*.

When the work commences in a rock above ground, it is usual to excavate a small well, as the water often rises to the surface, or nearly so; or the bore is enlarged for the reception of the pump.

To bring up large quantities from a small bore, hydraulic principles have been superadded; which induce a more lively flow of water to the boring, and up into the pumps. The former, by abstracting the column and making a vacancy much below the height to which the water ordinarily rises; the other by placing the pumps externally on the sides of the bore, lower than the height to which the water rises. Thus availing of the natural difference between the head and the position of the pumps; that thus, filling quicker, they may be larger, and deliver more.

To be successful, this art seems only to require suitable instruments and requisite skill; and there have now been so many instances, that it begins to become a rational inquiry, whether there may not be, in the *geology* of our country, good cause always to expect success; and, instead of looking to distant ponds and streams for a supply of pure water, whether there may not be a provision by Nature, even for cities densely peopled, on the very spot they occupy?

The researches of geology seem to have established the most material facts in this inquiry, that the *primitive* rocks are always stratified. It appears, that, while the earth was yet without form, and void of life, the crystallization which constitutes the rocks was going on, and forming them in strata; of which, the cause can be but conjecture. It is possible that the process extricated the substance that makes the division between them, till its quantity was sufficient to deposit; and, being settled, the crystallization recommenced, thus forming successive layers. But that, besides the strata of its own kind, general layers of different kinds should have successively formed, is not less true than curious. In one mass, they might not have been so easily raised into mountains. Thus the *primitive* rocks are, it is believed, invariably found in the order or succession, upwards, of granite, granular limestone with quartz, gneiss, mica slate, soapstone, sienite, succeeded by the *transition* rocks, metalliferous limestone, argillaceous and siliceous slate, graywacke slate, and rubblestone; which are again succeeded by the secondary rocks, red sandstone, breccia, compact limestone, gypsum, and rocksalt; and over these the diluvial masses, or aggregations of rocks and earth; and among them the recent alluvial deposits.

Thus the granite of the highest mountains must, in its formation, have been level and low; but, when the formation of the dry land took place, was upheve by some physical cause, which the Creator had prepared.

On the Alps, in the vicinity of Mont Blanc, stupendous masses of granite stand up thousands of feet, as if protruded through strata of more recent formation, which slope down from them.

It appears that much the same operations, on the grandest scale, have prepared the continents for the habitations of man. The same *fiat* which caused dry land to appear, created the vallies, and the plains, the streamlets, and the rivers, and set bounds to the sea.

On the continent of North America, there are, obviously, three distinct systems of mountains. The central line of the Appalachian, being the Allegany mountains, is granite. And the eastern border of the base of the system may be described as appearing at *the falls of all the rivers'* nearest tide, discharging into the Atlantic south of the Hudson. In Darby's geographical view of the United States, page 81, it is said, "this inflected line, from New-York to the Mississippi, is marked, at distant intervals, by falls, or rapids, in the bed of the streams."

The Allegany mountains, being two thousand four hundred and seventy-three feet high, attract and condense the vapors and clouds, and is well known to be a more rainy region than the plains below, giving rise to numerous rivers.

It is reasonable to think, that when the granite strata rose from their original position, that cavities were formed by their disruption, and that whatever spaces occur, must be filled with water, and be the passage for it thence among the strata to the ocean; and if so, this water may be *intercepted*, in part, by perforating the strata. This might have been reasonably expected, and this expectation has been verified by trials.

The nearest boring to the Alleganies is at the Public Armory, near Harper's Ferry, on the Potomac. The next at Baltimore; again near the Schuylkill; again at Princeton; then at New-Brunswick; Somerville; Amboy; Nowark; and Jersey City.

On the island of New-York there were stronger reasons for expecting to find water in the rock than elsewhere, because here commences the *third system of mountain formation*, dividing the waters of the *Hudson and Lake Champlain* from those of the bays of New-England. It commences here and extends northward, forming the mountains of Berkshire and Vermont. It is a range of primitive rock, the strata of which rise from the west and probably decline towards the east from the centre of New-England.

We have the authority of Professor Eaton, a teacher of Geology, to say that the strata of primitive rock, after spreading down from the west as far as the Hud-

son, begins to rise, and come to the surface in the Berkshire mountains. That they do thus actually slope upwards from the west is known by the excavations made in this island.

The city thus being at the point where the range commences its rise northward, at the same time the strata dip west, the waters therein *cannot* flow *east*, and must, of course, flow *south*. And that the spaces are full of pure water, is not only ascertained by its outpouring at the head of the streams of the Highlands in a thousand places, but by its actual abstraction here, in a number of instances, and by the *spontaneous outpourings* of it also *here* on the spot, in the very centre of the city.

The natural indications of water here were strong before any experiment was made. The rock springs of the 1st Ward were known before the Revolution; and the central valley, before it was occupied by streets, was the seat of large and deep collections of spring water; and one of these was, in 1798, deemed by the Common Council sufficient for the whole city; and it was a question whether it should not be *preserved for this purpose*. But it was filled up. Nevertheless, the springs which fed it are not lost: they continue to flow, and are, in fact, *recovered* by the effect of the deep tube above described. The two or three millions of gallons a day, which then flowed here, are regained and protected by a mass of earth from fifty to a hundred feet deep.

The proof of this fact is in the success of *three* tubes. Two of them in West Grand street, the other in Lawrence, near Canal, at Cram's distillery; and this one continually overflows on being reduced one or two joints.

There is also proof of the like issues of pure water on the east side, north of Chatham square, by the success of all the *tubes* that have been set down to the surface of the rock near the East river.

But on the west side the water is not obtained without penetrating the rock about one hundred feet, being on the top of the slope thereof, but this operation has in every instance been successful.

The general reason for expecting success in this operation being thus explained, the inquiry becomes perhaps the more interesting, how often the theory has been confirmed by practice? The instances have not been many, but are rather convincing. The least likely to succeed was that of the botanic garden, because begun on the bare apex of an elevated rock, about the highest ground in the island. It penetrates the rock 112 feet, and the water stands 94 feet deep, constantly renewed.

The next proof is one mile more south, at the great well of the Fire Engine Reservoir, 113 feet deep, of which 96 are in the rock, and considerable water is obtained.

West of this, near the Hudson, are those about one hundred feet deep, which supply the city with rock water, by means of drays; also, that at a distillery on Perry street, which gives 22 to 26,000 gallons a day.

More southerly, and on the highest part of Broadway, near Bleecker street, is that belonging to the Manhattan Company, lately the subject of consideration by the Board of Commissioners.

It will be recollected that this Company was instituted to bring in the Bronx water, which, at the time their charter was granted, was estimated to cost about 200,000 dollars; but, by more complete surveys, it was found very likely to absorb their whole capital of two millions, so as to defeat the purpose of employing the *surplus* of 1,800,000 as banking capital. The Company had employed double the amount of the original estimate in supplying the city with the best water they could command, when the progress of the art of boring for water came to the knowledge of the directors.

After making a well 42 feet deep, down to the surface of the rock, they penetrated it 400 feet, in the course of which operation good water was found between *all the lower strata*, and not less than *eight times*.

They were so well satisfied with the result, as to have it reamed to the diameter of 7 inches: and, by applying only the power of a *six horse* engine, raise about 130,000 gallons of water a day. And the Board of Commissioners pronounce it good and wholesome; it is in fact soft, and clear as crystal.

They also calculate that 42 such borings only would supply the city with six millions of gallons a day. This one cost ten thousand dollars.

The Company may possibly have expected to raise, at once, as much as would supply the pipes already laid down, by their agent, stated at nearly 700,000 gallons a day; if so, it was rather a too great demand on one boring, though this one is, in the improved mode of management, probably capable of producing considerably more than it as yet has done.

But from some other cause, probably the preference which the stockholders give to *banking* with their capital, their water-works are offered for sale to the city; and might well have been an object of purchase to any party competent to their perfection, as no doubt all the houses along an extensive range of pipes would take the water, were it all as good as that thus derived from the rock.

It has thus been shown why the *general formation of the country* is favorable to the system of deriving water from the rock, and why New-York, specially favored, has only to penetrate a little deeper than usual to find pure water in great abundance, at a moderate expense, and, when thus obtained, incomparably finer than that of the Schuylhill at Philadelphia, and free from all unfavorable influences of climate or locality: for, however dense the population of the city may be, the rock water is defended by the depth and nature of its channels.

An apology to your readers would be offered for the length of this article, but that the subject is now becoming an interesting one to most of our sea-port cities. At New-Orleans a company is incorporated, having a large capital, and a banking privilege. The Mississippi is perhaps the only river in our country that, like the Nile, comes at midsummer cool from distant mountains of ice.

But no stream can be other than a drain of the district it waters; and it is well known that impurities combine chemically with water.

The recent survey and report for an aqueduct route from the Croton, though at an expense very disproportionate to the present city, may be preferred by the community. But it is possible that the certainty and readiness, the inexhaustible nature of the sources which come hither in the natural aqueducts of the rock, have not yet been duly appreciated by the public. They certainly have not been by the commissioners; and it remains yet for public opinion to decide the interesting question, how the city of New-York shall be supplied with pure and wholesome water.

To leave behind so productive a source of supply as the rock affords, is like leaving a *fortress in the rear*.

This resource will, at all events, be the object of a company of capitalists. It has been solicited of the Common Council that leave be given to deliver it by aqueduct pipes. It is stated in the Water Committee's recent report, that the city actually pays 273,750 dollars for the water distributed by drays; and the shipping 50,000 dollars. They compute the number of

buildings for which water would be required at 35,000. They state that in the city of London there are eight water companies. It is not stated why the *Corporation* did not supply that city. The explanation would have been that, where capital is to be applied, those do it most economically who have the most interest in making it effectual. One of them is stated to have risen greatly in value.

New-York, January 11, 1834.

Undulating Railroads. By A. Canfield. To the Editor of the Mechanics' Magazine and Register of Inventions and Improvements.

Sir,—Having heard several of our most distinguished civil engineers express a disbelief in the theory of the undulating railroad as laid down by the ingenious discoverer of its advantages, (though they admit that they had not carefully examined the matter,) I am induced to offer some remarks on the subject.

What I propose to show is, that a car must and will run over an undulating road, with a moving power *less* than would be required to move it on a level road. Though, to my mind, this is abundantly proved by Mr. Badnall, I shall take a different course to arrive at the same conclusion.

Let us first suppose a car placed on a level road, and a locomotive power applied which is just sufficient to overcome all friction. Now, the smallest additional force will put the car in motion; and the velocity will be exactly proportional to the said additional force. We will suppose it to be so small as to produce the least conceivable velocity. Now, we will suppose the same car to be placed at one of the apexes of an undulating road. We will suppose the undulations to be segments of circles. Now, if a power is applied barely sufficient to overcome all the friction, it is certain that the car will run down and ascend on the opposite portion of the circle to the same height as that from which it started; and the principle of this movement is in no respect different from that of a pendulum vibrating in the same circle. If we then suppose the undulation or segment of the circle to be the same as that described by a "second pendulum," it will follow as an inevitable conclusion, that the car must pass from one apex to the other in *one second of time*. Here then is a certain distance on the undulating road passed over in a certain limited time, whereas, on the horizontal road, with the same moving power, the time occupied may be as great as can be imagined. You will observe, (and it is important,) that this result is obtained, notwithstanding that the friction is supposed to be constantly the same on both roads, and, of course, the amount of friction *greater* on the undulating, (as it is longer,) than on the level road.

But the most important fact is the one stated by the inventor, viz. that the pressure from a car is less on an inclined than on a horizontal road. This is certainly true, since a part of the gravitating force or weight of the car must be exerted, or expended, in accelerating the motion in descending; and the same portion of the gravitating force must be sustained, or overcome, by the moving power in ascending and the amount of pressure from which the rails are thus relieved is the same, whether the moving power be an impulse or a constantly acting power This leads to a very surprising conclusion, viz. that since the pressure upon the rails diminishes in proportion to their steepness, it follows that the steeper the undulations the *less* moving power will be required; and this must be the fact, until the pressure upon the road is so much reduced that the locomotive power will cause the wheels to slip on the rails. I here, of course, suppose that there shall be no loss of momentum in consequence of the change of direction of the moving body.

Another proposition that bears on the case is, that the pressure of the car on the rails is diminished in the same proportion as the velocity is increased, and from this cause the friction is lessened in the same proportion. To prove this in a few words, let us suppose such a velocity to be given to a car as will cause it to move parallel to the surface of the earth, without touching the rails; now, but a moment's thought is necessary to show, that if this velocity be diminished, the pressure on the rails will begin, and will increase in exact proportion to the diminution of velocity, and the friction arising from this pressure will increase in the same proportion.

If, then, it is proved that the friction or resistance to motion is less, it cannot be denied that the same moving power will produce a greater velocity on an undulating than on a level road; at the same time, I hold it to be proven by my first proposition, that if the friction were the *same* on both roads, that the undulating road still has a decided advantage.

I would not at this time go so far as to make an undulating road over a level route, nor do I suppose that very long or very steep planes can be used; yet I see no reason to doubt that this will be found to be one of the most important improvements that have been made in railroads.

I am, Sir, respectfully, your obedient servant,
A. Canfield.

Paterson, N. J., Jan. 2, 1834.

Mr. Symington, the Original Inventor of Steam Vessels. By Robert Bowie. [From the United Service Journal, for September.]

Mr. Editor,—The article concerning steam navigation contained in your last number has afforded me no little pleasure, as it assists materially in establishing the justice of the claims I am now engaged in advocating on behalf of a highly-talented and deeply-regretted relative, the late William Symington.

To alter the opinion of your intelligent and impartial contributor, with regard to Mr. Hulls, will, I am persuaded, require but examination of the mode proposed for constructing the machinery and applying the power of steam,—a mode which has been pronounced, by skilful and practical mechanicians, visionary and impracticable.

As to the Marquis de Jouffroy, his experiments are so completely unknown, that, for any benefit derived from them, they might as well never have existed. And it is the general belief respecting them that they were incomplete, and unfit for bringing the undertaking to a favorable conclusion. That such a belief was not unfounded may be inferred from the imperfect state of the steam engine of that day, and the failure of the subsequent and imitative attempts said to have been made by De Blan and Fulton; the latter of whom, Fulton, was only able to accomplish his object after having had an opportunity of minutely examining Mr. Symington's boat, receiving explicit answers to printed questions, and jotting down his observations as he was carried along the canal on board of the vessel.

Contending, therefore, that the mere idea of the practicability of steam navigation, without

the ability for its realization, possesses but little, if any value, I feel myself warranted in claiming for him who first successfully applies the power of the steam engine for the propulsion of vessels, the honor and credit of the invention; and I feel myself warranted in my proceeding, by the firm conviction that he was indebted to no one for the idea, it having occurred to himself long before he became aware of its ever having been entertained by others.

In 1784 he imagined it possible for steam power to be rendered applicable to terro-locomotion; and in 1786, he exhibited in Edinburgh a working model of a steam carriage. He then bethought himself that the same power might be rendered available for propelling vessels. His first boat appeared on Dalswinton Lake, in 1788, and his second on the Forth and Clyde canal the succeeding year: both of which as completely illustrated the practicability of steam navigation as any ever since exhibited.

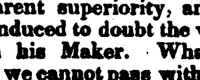
In your Magazine it is stated that the first boat appeared in 1789, on the Forth and Clyde canal, and resembled Hull's, in being a tug. This is an error, as neither the one of 1788, nor that of 1789, at all resembled the boat proposed by Hull; nor were they intended to be used solely as tugs; and furthermore, the first never made its appearance upon that canal. It was the vessel constructed twelve years afterwards for Lord Dundas, which was designed to be used for dragging shipping: a purpose which, on several occasions, she satisfactorily and successfully executed.

It has been attempted to represent the whole of these experiments as failures; but too much respectable and unquestionable evidence can be adduced in their favor to render any hostile assertions likely to be either accredited or believed—the more especially, as many practical well-informed engineers have declared their conviction that the machinery was well contrived, and its mode of application most ingenious. Indeed, the declaration may at once be hazarded, that in several important points it possessed many advantages over that which is even at present employed; and it may also be averred, that to be more highly prised, it needs but to be better understood.

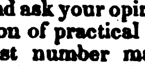
As a proof of Mr. Symington's ingenuity, and of the obstacles which genius will surmount, may be mentioned, that although Mr. Hull's patent rights were said to have been restrained, strictly guarded, and rigidly enforced, Mr. Symington invented and brought into use an improved steam engine, which was more simple, manageable, and economical for many purposes, than that of his celebrated contemporary and competitor, without, in the slightest degree, rendering himself liable to the charge of encroachment. And he gave still further evidence of inventive powers by *dismissing the beam*—a desideratum so important as to have called forth the following opinion from the writer of the article which has led to this communication: "And if the beam shall ever be dismissed, and a rotatory motion obtained, the triumph over inertia and friction will raise the wonder still higher."

On increasing the Facilities for Transportation by Water. By John N. Pomeroy. To the Editor of the Mechanics' Magazine.

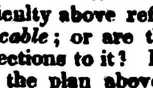
Sir—Although my acquaintance with you is very limited, I hope you will pardon the liberty I take in addressing you. My profession necessarily occupies a great portion of my time and attention; nevertheless, I am not indifferent to the progress of improvements which are going on at such an astonishing rate in our country. The wonderful facilities for rapid transportation afforded by the introduction of railroads, and its vast superiority, in velocity at least, to the modes of transportation on the natural water communications throughout the country, could not but excite the inquiry—"Is it true, then, that the various rivers and arms of the sea, which intersect the face of the earth, and which have been heretofore considered as great highways for the convenience of man, and designed as such—is it true that the progress of improvement is to prove these but *obstacles*, rather than *facilities*?" The present superiority of the railroad system would seem to indicate an affirmative answer to this question; but a reflecting mind would be unwilling to admit it, and would be led to inquire into the *reason* of the apparent superiority, and would, at all events, be induced to doubt the wisdom of man, rather than his Maker. What, then, is the reason why we cannot pass with equal (or with greater) facility and velocity through the water, as on the railroad? It is doubtless, chiefly, if not wholly, on account of the *law of resistance* to motion in fluids: can that be obviated? I do not hesitate to say it can, and will be. How? This leads me to the object of this letter, which is to describe a plan which I have invented for that purpose, and ask your opinion, and, through you, the opinion of practical men, of whom, I think, you must number many among your friends or acquaintances. It appears to me to obviate the difficulty above referred to; but is the plan *practicable*; or are there insuperable practicable objections to it? In order to give you an idea of the plan above mentioned, or machine, I may as well describe the one which I have made; first premising that the object is to have the *sustaining* part of the vessel the part which moves and *gives motion*. The machine which I have made is composed, first, of 25 tin cylinders, 8 inches long, 2 inches in



diameter, with caps at each end, water-tight, and a pivot also in each end, in the centre of the cap or head, say a half inch in length. These cylinders are connected together by a chain, composed of narrow strips of tin, having

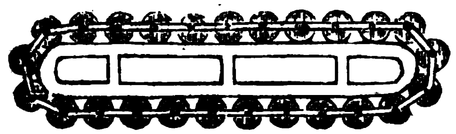


holes at each end, and placed on the pivots, so that the cylinders nearly touch each other, not



quite; and so, that the cylinders can revolve

on the pivots without interfering. These cylinders, thus connected at each end, are made to inclose the *hull*, or boat, which is (as I have



made it for experiment) a frame about 18 inches long, 8¼ inches wide, and 4 inches in height or thickness, and so turned at each end as to admit an easy path for the cylinders, and also so that the cylinders may strike the water in a proper direction. There is a flange on the exterior edge, or circumference of the frame, to prevent the cylinders from rolling off. It will now be perceived, I think, that a force exerted on the pivots in the same direction, on any one or more of the cylinders, that it will give motion to the whole, and when placed in the water, the machine, sustained by the buoyancy of the cylinders, must move as fast *ahead* as the cylinders pass through the water to the *stern*. This power in my machine is applied to the pivots of the cylinders by two wheels, on a shaft, which passes transversely through the machine, and plays on gudgeons at each end—the wheels adapted by cogs to act on the pivots, and the shaft turned by a spring.

Now, what are the practical objections to the above? I admit the first impression must be unfavorable—it is, as a water-craft, entirely *unique*; but, appearances aside, it may be said that a vessel on this construction cannot be made sufficiently strong to sustain itself in rough water, without being too heavy to derive the benefit proposed from the cylinders. It appears to me that the form of the *hull* is well adapted for strength, without much weight. As to the cylinders, it is more doubtful. I have supposed a vessel made of about 100 feet in length, and 30 feet broad, 10 feet high between the two floors, having 60 cylinders or barrels, each 30 feet long, 5 feet in diameter, and having 25 barrels, say, in the water, which would be about the number. Now, 25 of these barrels, *entirely* immersed, would sustain 450 tons; and it appears to me that a vessel *complete* of this construction and size might be made considerably within the limits; and it is to be borne in mind, that, from its mode of progression, it would not conflict with rough water, as ordinary vessels do, as the impinging cylinders would rather '*nullify*' than make war with the opposing element. Would it not be *top-heavy*, and careen? I see no objection to its being made sufficiently broad to avoid this difficulty. Would it not be incommodious? I should judge not, but the reverse, as the rooms might be made square, high, and with sufficient windows at the sides; and I see no objection to having *guards*, a deck fore and aft the cylinders, and a promenade deck over the cylinders. Would it require more power to produce a given velocity than ordinary steamboats? I think very far less; but the cylinders, which are in the water, would be much impeded in their revolutions (which must be rapid) by the water. If this be a difficulty, it may be avoided by wheels on the pivots, or gudgeons of the cylinders, which should sustain the cylinders and revolve on their axes, leaving the cylinders to pass the water without revolving.

I do not flatter myself that I have nullified all objections which may be raised to the practicability of the above plan. What I have said is by way of suggestion; and having had the subject on my mind for two or three years, I am anxious to relieve myself, by getting the opinion of experimental and scientific mechanics, as to its practicability and probable utility. The same principle, I am inclined to think, may be applied to railroad cars with many advantages.

Very respectfully, yours, &c.

JOHN N. POMEROY.

On the Petrifying of Wood, as applicable to Timber for Railroads, &c. By G. [From the American Railroad Journal and Advocate of Internal Improvements.]

Some time since, in an eastern paper, there appeared an article stating that some person had discovered a method of completely petrifying wood, and so preserving it nearly or quite indestructible, by saturation with HYDRATE OF LIME. If any of your correspondents can furnish any information of the process, or any facts which may elucidate the subject, perhaps they might render an important service to the cause of railroads, in situations which require or admit the use of wood; and I would respectfully suggest to any who may recollect such facts, that the communication of them to the Railroad Journal would be a gratification to at least one of its readers—probably to many.

It is said that timber imbedded in lime, under certain circumstances, as, for instance, the ends of beams inserted in the walls of brick houses, decays sooner than in the open air—becomes dry rotten, &c. I have heard it argued that this is owing to the causticity, or some other quality of the lime; and to prevent the effect, it has been a practice, in some cases, to leave a space for the ends of the beams, large enough for the free circulation of air around them, and free from contact with the lime used in the construction of the walls. Whether the facts observed in these cases fully justify the conclusion that time is always, or ever, injurious to the durability of the timber, I would not venture to assert, and it is not my purpose now to inquire. I am willing to admit the conclusion that it *may* be so in some cases; but I would suggest the inquiry whether its causticity may not be so completely destroyed by saturation with water, and in this state whether wood may not be so far impregnated with it as to become much more durable, and perhaps next to indestructible.

The notice stated at the introduction of this article, if it may be relied on as fact, answers the inquiry in the affirmative. Of the fact, however, I am ignorant, and therefore it is that I make this communication and inquiry. My object is to excite others to further investigations, and

with this end in view, I beg leave to state some facts of which I have been informed, which seem to me to prove sufficiently that lime may, in *some* situations, be made to contribute very essentially to the durability of wood; and, perhaps, may suggest a remedy, to some important extent, for the disadvantages to which wooden railroads are obviously liable.

Some years ago, I was travelling on the sea-coast of Maine, and put up for a night at the house of an elderly gentleman, who had been all his days concerned in ship-building and navigation, and appeared to be a sensible, shrewd observer. He had, that day, a new vessel arrived from her first voyage to a foreign port, and among other circumstances was told that she had not leaked a *drop* during the voyage. This led me to remark that she must have been exceedingly well built. He replied that he thought the tightness of the vessel was owing, in a measure, to the *lime* with which she had been stuffed while building. He had been led to believe that lime was a better preservative of the timber of ships than salt, or any other substance heretofore used for that purpose. While this vessel was being built, and before ceiling up the inside, he had the interstices of the timbers filled with new stone lime, pounded fine enough to be driven in between the timbers, and rammed in as solid as was possible in that state; the planking was then finished, and the lime left to slake and fill the remaining interstices. His theory was, that the air, and the moisture of the wood, and perhaps a little water, which might be expected to leak into the best built vessel, would slake the lime so that its expansion would fill every chink in the timbers, and penetrate the pores of the wood itself, sufficiently to prevent speedy decay; but any effect in rendering the vessel more staunch he had not anticipated. He, however, concluded that the expansion of the lime, though, from its small quantity, not sufficient to injure the vessel by its mechanical force, yet had been sufficient, by the addition of the little water which had leaked in, to form a mass of mortar so solid as to prevent, at least in some degree, the further ingress of water from without. This, however, was a new idea, and the present experiment was not conclusive; but as to its effect in preserving the timber, he had no doubt; and he related several facts in his own knowledge in support of this opinion.

As one instance, he stated that he had once owned a coasting vessel, built of the common timber of the coast of Maine, which, when nearly new, was once bound from Thomaston to Boston, with a cargo of lime, and on her passage went ashore somewhere between Cape Ann and Boston, and bilged. The lime slaked, burnt the deck and upper works, and, as might be expected, penetrated the timbers throughout. The vessel was unloaded, repaired, and lived, I think he said, thirty or forty years after this event; had undergone occasional repairs since, but the principal part of the original timber remained. When, after that that time, examined, it was found that the original timbers, which had been impregnated with the lime, were *perfectly sound*, while those which had been added *since* that time, were all, or nearly all, *rotten*. He adduced, also, the fact that vessels employed in carrying lime, generally, if not always, last longer than any others; and said that he had resolved thereafter to saturate, as far as possible, all his vessels with lime, as the best method of preserving them from decay.

Another instance was that of a parcel of pine planks which had been used as a platform, *on the ground*, on which to make lime mortar. This platform was laid by his grandfather, in a corner of the yard, and used more or less every year for the purpose of a "mortar bed." His father continued it in the same use; himself, the grandson, continued it for a time, as long as he had occasion; after which, it lay some years unused, and overgrown with grass and weeds; at length, wanting the ground for another purpose, he had it torn up and removed, expecting to find the planks entirely rotten—but, to his surprize, found them sound, and, to use his forcible expression, "as hard as a bull's horn." This was after they had lain in contact with the surface of the ground, exposed to all the vicissitudes of the atmosphere, I think he said, *about sixty years!*

It is now near 15 years since I received these accounts from the old gentleman, and I have never seen him since: my recollection, therefore, may not be perfectly accurate in the details of his statements, but of their *substance* I feel certain. When I saw the notice referred to in the beginning of this article, respecting the preservation of timber by means of hydrate of lime, these facts at once recurred forcibly to my mind, and I was led to the inference that, in the cases mentioned, there had been so much water present as to destroy the *caustic* properties of the lime, convert it to a *hydrate*, and hold so much of it in solution, and in such a situation, as that it might always be presented to the wood for its absorption, until it had become entirely saturated, and the wood thus effectually preserved.

Will some of your correspondents recollect, and furnish for publication in the Journal, such facts as may confirm or correct this inference, and trace out its legitimate consequences, if confirmed? G.

Safety Apparatus for Steam Boilers. By Alex. C. Twining. To the Editor of the American Railroad Journal, and Advocate of Internal Improvements.

Sir,—I have read several interesting articles in your Railroad Journal, the object of which was to propose one plan and another for protecting steam boilers against that danger of explosion which arises from the exposure of the flues to a violent heat when the water is permitted to descend below them. Respecting this hazard, (which is of frequent occurrence, as any man may be satisfied who takes time and pains to make extensive inquiries, and concerning which I speak reflectingly when I express the opinion that it subjects the traveller to more multiplied and more fearful risks than

any other circumstance attending the steam engine,) there can scarcely be too much discussion, until some adequate means of public safety in relation to it shall have been discovered and brought into common use. In this article I design to add one more to the proposed expedients for safety, after bringing up to view one or two principles which are necessary to a clear understanding of the precise object before us, and which are often overlooked by those who discuss this subject.

It is a principle, or, at least, it is a truth, which ought to take the place of a principle, not to be lost sight of on this subject, that mechanism, ever so excellent, cannot be made to supersede the practice of that same strict and personal examination by means of the gauge-cocks, which is now enjoined upon the engineer and other attendants of the engine. The propriety of this assertion will be understood by every one who is practically acquainted with the imperfection of materials, and knows that machines, put together according to the best rules of art and maxims of science, are subject, nevertheless, to irregularities, which, in mechanism for this purpose, though they occur but once in many years of time, do entirely prostrate the whole design. Nothing can be more simple, as a security against excess of steam in the boiler, than the present safety valve; yet, simple as it is, no one ventures to rely upon it without the attendant indications of the mercurial gauge; and if any arrangement equally simple shall ever be devised to meet the object now in question, as it is very probable there may, no wise man will rely upon it without the attendant indications of the gauge-cocks,—at least, until the construction of boilers shall make their explosions, when they do occur, altogether less destructive than they are at present. Indeed, if the vigilance and skill of those who are entrusted with the engine might be implicitly relied on, there would be little occasion for seeking any other safeguard: but *men* are scarcely less fallible than *mechanism;* and if the defects of this make it an uncertain dependence, the defects of the other ought, on the same principle, to teach us the necessity of providing a check against those causes of danger which do continually act,—such, for example, as deficient skill, or inattention, or drowsiness, or the use of spirituous liquors, or unforeseen accidental circumstances—causes that beset the passengers' way with dangers which a timely prevention generally disarms, but which sometimes give terrible demonstration that they are not imaginary. From such considerations we infer that no apparatus can do away with the necessity of that personal vigilance which is now the only dependence for safety—that the single end of an apparatus should be to provide a check upon those causes which make that first dependence sometimes to fail, and that such an apparatus is really most necessary, notwithstanding the opinions of many practical men to the contrary.

But, in forming such an apparatus, it should be a principle to make its indications of such a kind as to give the early notice of impending danger, not to passengers, but to those attendants on the engine whose business it shall be to apply the remedy. An opposite idea, it is true, has been incorporated into most of the current devices, for sounding or ringing alarms, or regulating moveable indices, open to the sense of all who may wish to gauge, at any moment, the precise dimensions of their travelling security. Not that bells or an index might not be so arranged as to give timely notice in the proper quarter only; but those projectors who have contemplated arrangements for indiscriminate alarm, have taken measures to defeat the success of their own projects, since experience has shown that the excitement and headlong impulses of a mass of people, acted on by the impression of impending danger, are almost as much to be dreaded as any common danger itself; and it is from their experience of this tendency, as well as from motives of immediate interest, and pride of personal feeling, that captains and proprietors would naturally discountenance every plan which would proclaim indiscriminately each momentary danger. The thing to be aimed at is to give notice when danger is at hand to those who have the means of averting it, and not at once to others; for, although it were ever thought a doubtful question whether passengers ought not at once to know the crisis, yet it is not a doubtful question whether captains and proprietors will readily consent that they shall; and still less is it doubtful respecting any specific means of safety, whether it will come into general use without the favor of those authorities.

These considerations, with others, led the writer many months ago to suggest to two or three individuals, of great skill in the steam engine, an arrangement for causing a small puff of steam to issue and alarm the engineer and firemen, in case the water should fall too low, while by others it would be undistinguished from the common sounds that now issue from the boilers, unless, indeed, the evil were permitted to continue uncorrected, in which case the increasing alarm would give indiscriminate notice of neglect and hazard. Since the time when those communications were made, an interesting article has found insertion in your Journal respecting a safety apparatus invented by Mr. Kennedy, of New-York, which, if I understand it rightly, embraces in its plan substantially the same idea. Mr. Kennedy, therefore, if that method of alarm shall be found to possess advantages sufficient to bring it into use, will be entitled to the merit of having first brought the idea up to public notice; though his particular arrangement, there is reason to fear, would fail of success, from a circumstance which deserves to be pointed out more specifically.

The circumstance alluded to, (and which, indeed, is common to most other plans that have been proposed for this object,) is that the rod, which connects Mr. Kennedy's float with his escape valves, is made to pass through the boiler in such a manner that this rod, or rather the "wadded stopper" which it works, is subject to the atmospheric pressure above, and

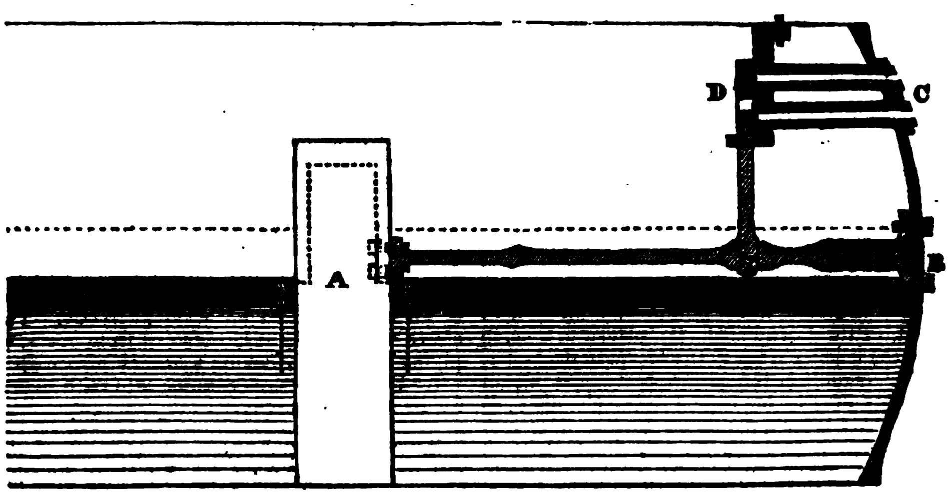
the steam pressure beneath; but as the atmospheric pressure is subject to changes equivalent to two inches of mercury, and the steam pressure in the boiler to changes much greater, it may be seen at once that a stopper of no more than one inch in area would be subject to influences which would of themselves greatly impair the accuracy of the indications of any float of moderate size. Add to this the friction of the stopper, which by reason of its packing must adhere to the tube with a considerable force, and there will be found in these three disturbing forces reason to apprehend a very capricious action of the float.

In my own arrangement, as well as the preceding, there are valves and a rod; but the rod is to work wholly in the steam, and is to be connected with the float by the intervention of a lever, which gives a considerable mechanical advantage,—say, an advantage of three to one. At the same time, packing is made unnecessary by the adoption of a metallic plate, working upon another plate in the manner of the common slide valve; but this will be more fully understood when we shall come to the figure and explanation.

None of the plans in your Journal, which I have noticed, except Mr. Kennedy's, have guarded against the uncertain amount of action in the float from its ebullition or foaming of the water. Mr. Kennedy has proposed a box, in which his float is to rise and sink; but I propose to accomplish the same object only by adapting the form of my float to that purpose, in the manner following: Suppose a float of the form and in the position of an upright cylinder, sunk just to touch the boiler at its lower end, or within an inappreciable distance of it, the water in which it floats being dead or free from ebullition; then when steam began to be generated, the water would swell in bulk and rise in height around the cylinder, but the upward pressure upon the cylinder's base would remain unvaried, since the specific gravity of the column above it is as much diminished as its height is augmented. The cylinder, therefore, would neither sink nor rise, but would retain its position unaltered until the absolute quantity of water in the boiler became itself altered. By adopting thus a cylindrical float, to sink in the dead water as near to the bottom as the requisite play of the float will admit, we may secure the necessary regularity of action. But, in case it should be inconvenient for the float to sink so deep, let us suppose the immersion to be only to a part of the water's depth—it may be one-third, or one-fourth—then, if the immersed cylinder suddenly break off in its shape to a less diameter at the water line, forming a smaller cylinder, resting immediately upon the larger, and united to it at the precise line of the water, and if the cross section of the smaller bear the same ratio, in area, to the cross section of the larger, that the immersion in dead water of the combined float bears to the average depth of dead water required in the boiler, such a float will be very nearly stationary when the water changes from its dead state to a state of violent ebullition, or foaming. By the principles of hydrostatics, it would be perfectly stationary if the density of the floating column of water in ebullition were alike from bottom to top; but this is not the case in reality, by reason of the bubbles of steam enlarging a little as they ascend, and the greater quantity of steam thrown up along the sides of the boiler establishing a superficial current from the sides to the middle. The variation from equal density, however, in the middle, is not great, and it is in favor of the float's descending too low when the water foams: which is on the side of safety. One of the gentlemen to whom I had communicated, in conversation, the principles of this apparatus, objected to hollow floats; that he had often in the actual trial found them unaccountably to fill with water. This result was doubtless occasioned by minute imperfections in the metal and workmanship, which did not manifest themselves until the float became subject to the steam pressure in the boilers, and to the corrosive action of the water and gases. These imperfections it may not be easy wholly to avoid; and the objection led me to adopt, in my proposed arrangement, a float entirely open at the bottom, which would always be emptied of water by the ascending steam, and its buoyancy kept unimpaired so long as there is occasion for its action.

Before leaving this subject, I will remark upon one mechanical principle, which, if real, possesses the greatest practical importance. The nature of the danger which is to be dreaded, in the case of a deficient supply of water in the boiler, is very generally understood—that is, if the water line descends below the flues, they become intensely heated, and when the water, either by ebullition or by injection through the supply cock, again reaches the incandescent metal, an immense quantity of vapor is immediately generated, which neither the safety valve can discharge, nor the boiler sustain. This is a common and satisfactory statement, and one which receives confirmation from the valuable experiments of Professor Johnson, of the Franklin Institute. There is, however, a mode of action in this vapor, and one which may be, in particular cases, of intense efficacy, that involves a mechanical effect additional to those above mentioned; and I embrace this opportunity of calling the attention of men of practical science in the steam engine, to the principle involved, as I do not remember ever to have met with it. It is well known that, if a charged gun barrel be so loaded as to leave a considerable space between the ball and charge, the piece will burst when fired. The French, and I believe the military rationale of the fact is, that the flame, reverberating from the ball back to the charge, creates a more perfect and sudden inflammation in the chamber than would otherwise take place. But, although this explanation does assign a real cause, we might ask whether the amount of gas thus suddenly evolved, can exceed that which was pent up in the same chamber, at the proof of the piece with double or even treble charges, and weight of ball? A more adequate cause might

be assigned, arising out of the established principles of re-action: for when inflammation of the charge takes place, the whole volume of gas, urged by a pressure equivalent to hundreds of atmospheres, rushes towards the muzzle of the piece; but when it meets the ball, there is a sudden check in the moving mass, which must re-act laterally upon the chamber in the manner of a shock or blow. The accumulated force which the gaseous material has been progressively receiving from its evolution to its impact on the ball, is brought to bear in one instantaneous impulse on the sides of the piece which cannot resist the momentum, and swells or bursts. A most able mechanician, the same who is engaged in conducting the gun factory of the late Eli Whitney, of New-Haven, informed me, not long ago, that, at one period of their inspections by the United States' officer, more than a hundred barrels were ruined by being swelled or burst at the chamber, from some cause most inexplicable to the artificers, till at length they made a ponderous rammer, to drive home the balls with most unerring certainty, and the mysterious effect was experienced no longer. Now, to apply this principle of force to the subject in hand, when, in the case supposed, the water, by ebullition or by injection through the supply cocks, reaches the incandescent metal, not only an immense volume of vapor is suddenly generated, but, being generated within narrow limits, it must rush on every side with great velocity, and reach the limits of its confinement with accumulated momentum, and a shock similar in kind (though vastly less in amount) to that experienced in the case of the gun barrel already dwelt upon. This principle of force is a real cause of rupture, of an unknown degree of efficacy, and one which ought not to be neglected by practical men; for it may sometimes occur, in consequence of the same mode of action, that even without a deficiency of water, but merely from excess of steam, our present means of safety may become a cause of explosion; for if an overstrained boiler were suddenly relieved from its state of undue tension by a hasty opening of the escape valves in full, the water, being of high temperature, would fly into steam, which, though not in volume too excessive for the boiler to bear, would certainly rush with an upward motion to the limits of the boiler, and encounter the resistance there with a shock which might prove fatal. In every such case the escape valves should be opened very gradually. This may possibly prove to be the explanation of the circumstances which have been accounted so mysterious, that boilers placed apart, and connected only by the steam eduction pipes, manifest a sympathy, through which, in case of rupture, a second boiler often follows the destiny of the first: for instance, in the late disaster of the New-England, which was caused, it is believed, by excess of steam, and not by deficiency of water, it cannot be supposed that the two boilers were so nicely matched in strength that a given pressure in the same instant shattered both; but it may be supposed that, when the first exploded, and pressure was thus taken off the second through the eduction pipes, water flashed into steam in quantities equal to the discharge through the vent opened through the pipes, and met the boiler, already strained to its limit, with a momentum which proved fatal. This idea is countenanced by the distinct, yet very contiguous, explosions of the first and second boilers in that unhappy disaster.



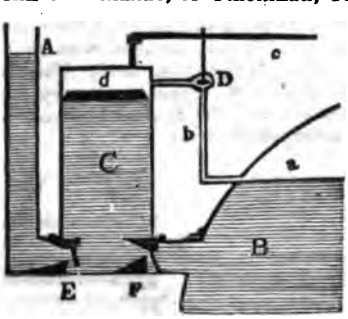
I now proceed to explain the prefixed figure, which is intended to represent a middle and vertical section made longitudinally through the boiler, and safety apparatus proposed and alluded to in the foregoing remarks. A B represent the lowest admissible water line; and the dotted line, above, the highest. At A is a cylindrical float, extending nearly to the bottom of the water; or, for the uniform cylinder, may be substituted the two cylinders combined in one float, as shown by the dotted figure at A. If this form be adopted, the lower cylinder must lie wholly immersed, when the water is free from ebullition, and the small-

er must be as much loss in cross area as the depth of immersion is less than the depth of water, in order to counteract the effects of ebullition. The float which is adopted must be open at bottom, to admit steam; and tight at the top and sides. It is to be attached to a lever, A B, working vertically around a fixed axis at B, and carrying the slide D by means of the rod shown in the figure, which must be so attached to the lever as to allow a slight horizontal play at the point shown at the bottom of the rod. The water line being shown in its lowest admissible position, it will be seen that, if it descend lower, the orifice in the sliding piece at D will come into junction with the lower orifice C, and emit a puff of steam into the fire room; and the lower the water descends, the greater will the quantity of steam which is emitted become. But if so much water be injected as to raise the water line above the dotted line parallel to A B, the orifice D will come into junction with the upper orifice C, and steam will be emitted thence.

The subordinate fixtures and arrangements there is no necessity for explaining. I would only add, that every thing in this arrangement, of which I am the author, is at the service of every one who can use any part of it to advantage. I am, Sir, yours, respectfully,

Alexander C. Twining.

We annex the following plan, suggested by Mr. John S. Williams, of Cincinnati, Ohio:



The principle may be thus applied:—Place the water chamber (C) either against the boiler, or at a distance on a level with it. This chamber must have one valve (E) opened toward it from the supply water, and another (F) from it towards the boiler, on the principle of the seat of the common force pump. By an escapement, or three-way cock (D), placed in a small pipe (b) leading from a, the steam in the boiler, to the chamber, the atmospheric and steam pressure may be alternated in the chamber, so as to allow the supply water first to flow into the chamber through E, and then from it through F to the boiler. No force is required, except to work the very small escapement in the alternation pipe; and never while the supply water in A, and operation is kept up, will the water in the boiler rise higher or sink lower than the line a, above the level of which the chamber shall have capacity equal to the waste during the operation. d is a float to prevent condensation.

Or the same result may be produced, by placing the chamber C something higher than above described. Let the water in the supply pipe, reservoir, or cold water pump, A, be kept higher than the chamber C, which is furnished with valves, E and F, as before. Let the entrance of the alternation pipe, b, be exactly at the water line a in the boiler B. By means of the lever *c*, work the double puppet valve D up and down; or provide any means so as alternately to shut the steam and air out of the chamber C. This is all the power required. It is evident that if the water in the boiler should be lower than a, the chamber would pour in more than the water, and raise the water to a; but if the water should happen to be higher than a, no steam could pass through b to displace the water in C; and of course there would be no supply until the water would be evaporated down to a, where it would stand for ever, provided the supply water in A, and the opening and shutting of D, were continued. When the steam is down, the boiler might be filled through E and F.

If the chamber C were placed in the common condenser, and subject to the action of the escape steam, the necessary supply of water, and no more, would be heated.

One apparatus will supply any number of *connected* boilers; but should one be attached to each boiler, and the boilers unconnected, a boat might be ever so much, or ever so long listed, without a possibility of the water being more exhausted in one than in another; and no more sediment would be collected in one boiler than in another. If, in addition to this, were each boiler furnished with a valve in the steam pipe, opening toward the cylinder, the following benefits would be the result of the arrangement. A weak boiler or flue would not be subjected to the strain of an accidental surcharge of steam in another. Should a surcharge happen in one boiler, it would occupy the whole safety valve for its relief. Should one boiler burst, or a flue in one collapse, the others would not be affected by it, and not a stroke of the engine would be lost, but the remaining boilers would continue to work the engine as if nothing had happened, unless the bed were deranged. Were one boiler to burst, that, and that only, would exert its power to destroy the boat and crew, and to derange the bed: whereas by the present system, the force of all is exerted by an accident in one. The above results might be obtained from one supplying apparatus, having a branch pipe with a valve F and stop cock, running into each boiler, for its separate supply.

Thrashing by Steam.—A perusal of the following article, from the Fifeshire Journal, may afford our readers a subject to introduce a train of thought on the destined introduction of steam machinery into agriculture.

Steam thrashing machines are continually obtaining more favor among agriculturists, and when the greater convenience and increased cheapness of such an assistant on a farm are

taken into consideration, the preference given it over the mills now in use will not be a matter of wonder. A machine of four horse power will thrash about 60 bolls [240 bushels, we believe,] in a day, supposing the crop to turn out moderately well, and the consumption of fuel for this work is at the utmost 8 loads of small coal, at 7d. each, amounting to 4s. 8d.; the driving, *if very distant*, may take a pair of horses one day, which call 4s. more; the whole expenditure for the power of the machine would thus amount to 8s. 8d., taking it under the most unfavorable circumstances. A mill of the same power (worked by two pair of horses) will only thrash 30 bolls, if the cattle are not overdriven, and as the keep of each pair cannot be reckoned at less than 4s. per day, there will thus be nearly the same expense for power, with only half the quantity of work. But this is not the whole advantage of steam, for it is well known among farmers, that the heavy incessant drag of the thrashing mill is most injurious to horses, and causes more wear and tear in their constitutions than any other portion of their labor. If the usual contrivance is employed to make them all draw equally, a horse of less stamina than the rest soon suffers by it; and if they are allowed to pull, each in its own fixture, some of the spirited cattle do all the work, and are hurt by it. Nor is the convenience less in another point of view, for it often happens that a farmer finds it desirable to sell, when he can very ill spare his horses for thrashing, and is thus obliged either to lose the opportunity of making a good bargain, or to let some part of the work of a hurried season stand back to set the thrashing mill in motion. Farmers, who have had experience for some time of the steam engine, say that they could not, beforehand, have imagined the convenience it affords them; on a farm of four pair of horses, an engine of the power we have mentioned enables the farmer to do with three, and the remaining beasts, being no longer pulled asunder and exhausted by the heavy toil of the mill, are in better condition than before. Large machines, however, are no advantage, and we should think that any farmer in Fife would be sufficiently accommodated with one of four horse power. To thrash 56 or 60 bolls is surely expedition enough for the most active farmer, and more can hardly be necessary at any time. The large engines require a greater expenditure of coal to heat them and get up the steam, and as this is equally necessary, whether much or little work is to be done, a great deal of coal is lost on every occasion, where the quantity of stuff to be put through the mill is not considerable. The steam-engine of four horse power may cost about £100, or a little more, which is nearly £30 above the ordinary mill; but for this increased outlay, the cheapness of working is a complete and sufficient compensation. The subject is one which deserves the attention of landlords as well as tenants, and it will, if we are not mistaken, lead to still greater changes and improvements. If steam-engines were once common about farms, their agency would often be found useful for purposes which at present are not thought of, and the possession of such a disposable power, like a giant continually under his command, will enable the farmer to turn many things to advantage which are now neglected.

Novel Machinery.—A few days since we were permitted to examine the operation of a machine, propelled by steam, for manufacturing *hooks and eyes*. It is a little affair, that might nearly be packed away in a gentleman's hat; yet its regularity of motion, and the simplicity of its contrivance, in making those crooked things with the rapidity of the ticking of a watch, all fit for a lady's dress, called forth our highest admiration.

The turning of gun stocks, shoemakers' lasts, and ox yokes, besides several other queerly shaped every-day conveniences, with which the farmer, the soldier, and the mechanic, are familiar, must certainly be considered the *ne plus ultra* of native ingenuity.

There are several ponderous cast iron machines for sale in a loft in Broad street, the invention of a Yankee, for making common brass pins. A child, by turning a crank, for aught we can discover, might manufacture a bushel a day, all headed and pointed for use.—[Boston Tracts and Lyceum.]

Indigenous Animals.—It has been doubted whether red foxes, mice, rats, the common black fly, the Hessian fly, the honey bee, fleas, moths, bed bugs, and cockroaches, are indigenous to this country.

It appears that the unanimous testimony of the Indians is, that the red fox did not make its appearance until after the Europeans had settled the country, and this was after an extraordinary cold winter, when all the sea to the northward was frozen. Hence it has been inferred that it came over from the north of Europe or Asia on the ice. Another account is that a gentleman of fortune, in New-England, imported a number for the sports of the field, at the first settlement of that country, and that from this stock was propagated the race. It is well understood that our red fox is the same as that of the old world. Kamschatka abounds with them; and when Commodore Bering landed on the western coast of America, he saw several; and Lewis and Clarke also observed them on the west side of the Rocky Mountains. A very severe winter may have driven vast numbers from the regions of the north, into the lower country, about the time mentioned by the Indians, as it frequently has other animals, and particularly squirrels, deer, and bears. Severe cold produces famine, and famine causes the migration of men, as well as of other animals. Little credit is to be reposed in the opinions of savages on such subjects.

Almost all the other animals have proba-

bly been imported; but this does not disprove their being also aborigines of America. Fleas have been found on gray squirrels and rabbits, killed in desert parts of the country, where no human creature ever lived; and in new settlements made on pine lands they abound. The cockroach, or blatta orientalis, is said to have been imported from the West Indies; but, on the other hand, it has been found in the midst of woods and deserts. The common mouse and the rat have also been seen, at an early period, in the crevices of stones and subterranean grottoes in remote mountains, where no human being had ever been before. The black rat is probably a native of America, and the gray rat imported from Europe.—[Transactions of the N. Y. Lit. and Phil. Society.]

History of Astronomy—its various Systems.

[Continued from page 46.]

Respecting the light of the sun, little was known till the time of Sir Isaac Newton. Before his time light had always been esteemed a mere quality or modification of matter; but it is now generally believed to be a *real substance*, or distinct species of matter, emanating or flowing from some luminous body, although in exceedingly small particles. It is also known that these particles proceed from the luminous body in straight lines; but their velocity exceeds every species of motion with which we are acquainted.

The velocity of light is to the velocity of the earth in her orbit as 10,300 to 1, although she moves at the rate of 68,000 miles per hour; therefore light flies at the rate of 167,878 miles per second, which is about 1,580,000 times faster than a cannon ball. This prodigious velocity of the particles of light, if they were not exceedingly small, would prove fatal to our eye sight; for they would strike us with such force that our eyes could not bear the shock.

The time which light takes to arrive at the earth from the sun is 8′ 13″. This was discovered by Roemer, a Danish astronomer, in the year 1644. By comparing the eclipses of the first satellite of Jupiter with the times of its immersions and emersions, given by the tables of Cassini, he found that the error of the tables depended on the distance between Jupiter and the earth; and hence he concluded that the motion of light was not instantaneous, and that it moved through the diameter of the earth's orbit in about 11 minutes. This, though a sufficient discovery or proof of the progressive motion of light, was not accurate enough to determine its true rate of velocity. However, this was soon after discovered by Dr. Bradley to be what it is stated at above. The intensity of light and heat varies as the square of the distance: for if an object be placed one foot distant from a candle, and another two feet, the one that is two feet distant will only receive one fourth part of the light that the other does; and if it be removed to the distance of three feet, it will only receive one ninth part, and so on. It is the same with respect to the heat imparted to any body.

Of the Planet Mercury.—Mercury is the nearest planet to the sun, and performs his revolution round that luminary in the shortest period of all the planets.

The time he takes to perform his revolution is 87d. 23h. 14′ 32·7″*, which is the length of his year. The length of his day, or the time he takes to perform a revolution round his axis, is not known; for, by reason of his proximity to the sun, few observations can be made upon him. He is so near the sun that he can seldom be seen, and when he does make his appearance, his motion is so rapid towards the sun, that he can only be discerned for a very short time. When he can be seen, it is a little before the sun rises in the morning, and a little after he is set in the evening. His distance from the sun is 36,668,373 English miles, and his diameter is 3,241 miles, which makes him about one-fifteenth part of the size of the earth. The rate at which he moves in his orbit is not known. The light and heat he receives from the sun are seven times greater than the earth, and the sun appears seven times as large to him as to the earth.

This planet appears to us with all the various phases of the moon, when viewed at different times with a good telescope; but he never appears quite full, because his enlightened side is never turned directly towards the earth, except when he is so near the sun as to be lost to our sight in his beams. His enlightened side being thus always turned towards the sun, proves that he shines not by any light of his own; for if he did, he would always appear round and fully enlightened. It is also plain he moves in an orbit within that of the earth's, because he is never seen opposite to the sun, nor above 56 times the sun's breadth from him, his greatest elongation being about 28°. In heathen mythology, Mercury is styled the Messenger of the Gods.

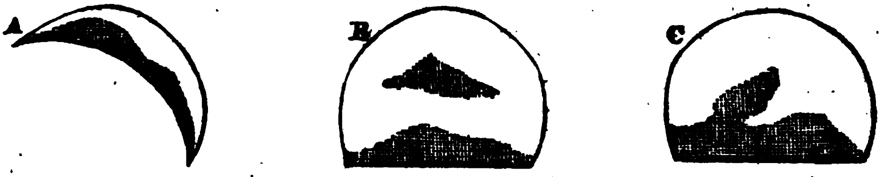
Of Venus.—Venus is the next planet in

* The time which any planet takes to perform its revolution round the sun, is called the length of its year; and the time which it takes to revolve round its axis, the length of its day.

order, and computed to be 68,518,044 English miles distant from the sun. She moves at the rate of 76,000 miles per hour; and completes her revolution round the sun in 224d. 16h. 41′ and 28″.

. The ime she takes to revolve round her axis, or the length of her day, is by some astronomers stated at 23h. 21′, and by others at 24h. 8′. Venus is much about the size of our earth, her diameter being 7,687 miles. When examined by a good telescope, she exhibits the same phases as Mercury and the moon; and her surface is occasionally variegated by darkish spots. These spots were employed by Cassini and Bianchini in determining the revolution of Venus about her axis.

In the following figure A represents Venus, according to the late Sir William Herschel, and B C according to Shrotter.



Venus is never seen opposite to the sun, nor more than 96 times the breadth of that luminary from his centre, her greatest elongation being about 47°, which proves that her orbit includes that of Mercury. When Venus is to the west of the sun, she is to be seen before the sun rises, and is then called the morning star; when she is east of the sun, she is to be seen after he sets, and is then called the evening star. Venus is in each of these situations for 290 days together. This may at first seem surprising, that she should keep longer on the east or west side of the sun than the whole time of her revolution round him. But when it is recollected that the earth is all the while going round the sun the same way, though not so quick as Venus, the difficulty vanishes. For the relative motion of Venus to the earth must, in every period, be as much slower than her absolute motion in her orbit, as the earth during that time advances forward in the ecliptic, which is 220 degrees. To us Venus appears brightest when her elongation is about 40 degrees, both before and after her inferior conjunction.

Some astronomers have imagined that they perceived a satellite near Venus; but this has since been proved to have been an illusion; for in her transit over the sun's disc, she appeared unaccompanied by any satellite.* Mr. Ferguson thinks Venus may have a satellite revolving round her, though it has not yet been discovered; and adds "that this will not appear very surprising, if we consider how inconveniently we are placed for seeing it."

Of the Earth.—The earth performs its revolution round the sun in an orbit between that of Venus and Mars, at the distance of 95,173,000, in 365 days, 5 hours, 48 minutes, 49 seconds, which is called the solar or tropical year. In performing its annual circuit, the earth travels at the rate of 68,000 miles every hour, which is 140 times faster than that of a cannon ball. The diameter of the earth is 7,912 English miles, and its circumference 24,855·42 miles.* That the earth is round, like a globe, is evident from its shadow in eclipses of the moon: for, 1st, the shadow is always bounded by a *circular* line, although the earth be constantly turning its different sides to the moon; 2d, by people at land only seeing the upper part of the mast of a ship when she first comes in sight, and as she approaches the land the whole of her gradually becoming visible; 3d, by its having been sailed round by many navigators. Several degrees of a meridian circle on the earth's surface have been measured in different parts, by which it has been discovered that a degree is longer at the poles than at the equator, and therefore the true figure of the earth is that of an oblate spheroid, the equatorial diameter exceeding that of the polar by 26½ miles. This deviation from the real spherical shape is occasioned by the diurnal rotation on its axis; for the gravity of the equatorial parts is diminished by the centrifugal force arising from their rapid motion, while the gravity at the poles suffers no diminution.

Of Mars.—The planet Mars is 4,142 miles in diameter, and performs his revolution round the sun in 686 days, 22 hours, 18 minutes, at the distance of 144,588,575 miles. His motion in his orbit is about 55,000 miles per hour. The time he takes to revolve round his axis is 24 hours, 39 mi-

* A transit of Venus happens very seldom. Only two occurred in the last century; one in 1761, and the other in 1769. There is not to be another till the year 1874. Transits of Mercury happen much oftener. There was one of this planet in 1822; but it was not visible in Britain.

* This is what the French mathematicians have lately deduced from a measurement of above 12° of the meridian.

nutes, of our time. The quantity of light and heat which Mars enjoys is only equal to half what the earth enjoys; and the sun only appears to him half as large as to the earth. This planet being only about a fifth part of the size of the earth, if any satellite attends him, it must be very small, and has not yet been discovered. To Mars, the earth and moon appear like two moons, a larger and a smaller, changing places with each other, and appearing sometimes horned, and sometimes half or three-quarters enlightened, but never full; and never above a fourth part of a degree distant from one another, although they are 240,000 miles asunder. Mars is very remarkable for the red color of his light, and for the great number and variety of spots which mark his surface.

The following figures, A, B, C, and D, represent the different appearances of Mars as seen by the late Sir W. Herschel, through the astronomical telescope; they are therefore inverted.

A  B  C  D 

The atmosphere of this planet, which astronomers have long considered as of an extraordinary size and density, is the cause of the singular redness of its light.

When observed by a good telescope, Mars sometimes appears gibbous, or more than half, but never horned, which shows that his orbit includes the earth's within it, and also that he does not shine by any light of his own.

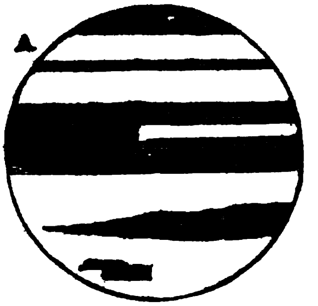
In heathen mythology, Mars is styled the God of War.

Of Jupiter.—The planet Jupiter is the largest of all the planets, his diameter being 89,170 English miles. The time he takes to perform his revolution round the sun is 4330 days, 14 hours, 39 minutes; but his motion round his axis is extremely rapid, being completed in the short space of 9 hours, 55 minutes. His distance from the sun is stated at 492,665,207 English miles; and his hourly motion in his orbit at 25,000 miles.

The form of Jupiter, like that of the earth, is an oblate spheroid, the equatorial diameter being to the polar as 14 to 13.

When this planet is examined through a good telescope, several belts or bands are perceived extending across his disc, in lines parallel to his equator.

These belts are variable, both in number and position. The following figures, A, and B, exhibit the appearance of Jupiter, according to Sir W. Herschel.

A  B 

Different opinions have been entertained by astronomers respecting the cause of these belts. By some they have been regarded as clouds, or as openings in the atmosphere of the planet; while others imagine them to be of a more permanent nature, and to be marks of great physical revolutions, which are perpetually changing the surface of the planet.

The sun appears to Jupiter only of one twenty-eighth part of the size he does to the earth, and the light and heat he derives from that luminary are in the same proportion. But he is in some measure compensated for this want by the quick return of the sun, occasioned by the prodigiously rapid motion round his axis; and by four satellites which move round him, at different distances.

These four satellites were discovered by Galileo, an Italian astronomer, in the year

1610. They may be seen by a telescope which magnifies thirty times, and are found to be of great use in determining the longitude of places on the earth, by their immersions into his shadow, and their emersions out of it.

These satellites are of different magnitudes; the second being the least, the third the greatest, and the fourth the *second* in magnitude. The time which each of these satellites take to go round Jupiter is as follows: The first, or nearest to him, 1d. 18h. 27′ 33″; the second, 3d. 13h. 13′ 42″; the third, 7d. 3h. 42 33″; and the fourth, 16d. 16h. 32 8′.

The eclipses of these satellites, by falling into the shadow of Jupiter, have not only been of advantage in enabling astronomers to ascertain the longitude of places, but were the cause of that most curious discovery, made by Roemer, in the year 1675, of the successive propagation of light.

On Mechanics' Institutes. By S. Blydenburgh. To the Editor of the Mechanics' Magazine.

Sir,—I examined with peculiar satisfaction the report of the Mechanics' Institute of the city of New-York, which was handed me by your friend Mr. Walsh, having long felt a deep interest in the subject of association for the purpose of improving and increasing the stock of knowledge among practical mechanics, on subjects connected with the useful arts. It is by the help of this knowledge alone that man is changed from the savage to the civilized state, and every step it advances is a commensurate advance in civilization. It must be obvious to every reflecting mind, that the progress of improvement in the arts has been in amazingly different ratios at different periods, and under different circumstances; and it must be equally obvious that the causes which have more than all others accelerated that progress, are liberty and association. It is no less true than worthy of observation, that where any number of persons associate for the purpose of mutually gaining and communicating knowledge, on any subject, the stock of knowledge is increased nearly as the square of their numbers. How important then must it be, that men should adopt that course which is, of all others, the best calculated to promote that cause which is the most essential to the temporal happiness of mankind.

The stock of human knowledge in the useful arts is an accumulation through successive ages of experience, from time immemorial; but much of this stock has been lost by want of association, and through an erroneous policy. Each important discovery was kept secret, and either cautiously transmitted to the descendants of the discoverer, as a sacred *arcanum*, or died with him. But whether public or private, those discoveries were of little use in promoting general happiness. The ingenuity and the labor of the human family were considered as equally the property of the tyrant who governed it; and both were exclusively appropriated either to pamper his pride while living, or to perpetuate his name when dead. The more he could depress his fellow creatures the greater was his relative elevation above them. When we reflect, therefore, on the stupendous grandeur and exquisite workmanship still visible in the ruins of antiquity, instead of regretting the fancied degeneracy of human intellect, we ought to consider that those monstrous fabrics were constructed by the labor of slaves, and the ingenuity which beautified them was rewarded by the hard earnings of wretches, deprived thereby of the comforts of life. No wonder that arts were then kept secret, and died with their inventors.

Science was then of no use to the practical artist, nor even to any body else. Indeed, all it could boast was mere hypothetical speculations, which served only to gratify idle curiosity, or to aid the power of magical delusion, in producing mental slavery, more degrading and more to be dreaded even than physical. These reflections will at once account for the amazing and almost inconceivable displays of human ingenuity, since the spirit of liberty has awakened the dormant powers of genius by its vivifying influence.

Science and art are twin sisters, designed by nature for the mutual benefit and support of each other; but, by the above causes, they have been alienated and estranged from each other through the entire lapse of past ages, until the present auspicious era has reconciled and united these two, so useful to each other. Science has now become convinced that she not only owes her discoveries principally to the assistance of art, but that it is art which furnishes her with the substantial comforts of life. Art has also discovered that the light of science opens to her view a road to perfection, towards which she was only groping her way in darkness.

It now begins to be understood by men of discernment, that a knowledge of practical things would be of more use to the rising generation than the course of education now pursued in our highest seminaries of learning—that they would be more benefitted by

studying the useful arts, aided by the light of science, than by spending those years in studying dead languages, which ought to be employed in acquiring ideas. Our young men, also, begin to be aware of this important truth, and to feel the influence of the spirit of improvement. Nothing is now wanting but to nurse the incessant spark which is kindling—to aid the first impulses of inquiry by such publications as you are now engaged in; and we shall soon find that the age of improvement is but dawning, and that the amazing displays of art and ingenuity, we have already seen, are but a faint prelude to advances yet to come.

But as we have yet no schools where science and art are blended and taught in their proper relation to each other, the desired object can only be attained by association. By this, not only the young men of our county, but even their seniors, can unite their efforts, and by interchanging ideas, put their joint knowledge into common stock, and also by their joint contributions meet expenses in books, reports, apparatus, and lectures, which would be generally beyond the reach of individuals. The example of the metropolis might be followed in every county in the state, and those branches communicating with the parent association, and with each other, would become a system of mutual aid and improvement between each individual branch and all the rest.

To excite a disposition to commence so desirable an object, many ways may be devised by yourself and your correspondents. Among others, I think it would not be improper for the institute to order its secretary to forward a copy of its constitution to some suitable person in each county; and, could it be obtained, an address from the society on the subject would no doubt have a salutary effect. With strong hopes that so useful an object will be effected, I will trespass no longer on your patience, or that of your readers. S. Blydenburgh.

Lansingburgh, Jan. 21, 1834.

We are much gratified that our esteemed correspondent has taken up this matter in good earnest. We were among the very first originators of institutions of this kind in England; and knowing, as we do, the great benefits that have arisen from their introduction there, we shall be proud in rendering any service in our power towards their promotion in this country. We hope that Mr. Blydenburgh will exert himself to establish them in his immediate vicinity, and shall be happy to give publicity to his successful efforts, in the hope that it will stimulate others to "go and do likewise."

Drill Machine—Important Improvement.—Last year Mr. John Geddes, farmer and joiner, Cargen bridge, who some time ago received, from the Highland Society of Scotland, a handsome premium for the best turnip drill-machine now in use, invented an apparatus for sowing and harrowing, which weighs 50 lbs., may be purchased for the same number of shillings, and is so exceedingly handy that it can be attached in five minutes to a common plough, and set in motion to the astonishment of the sheeted seedsman, and his friend the harrower, who foresee in this invention their occupation gone, with the exception of oats, and that too in the course of a few years. In the first instance, our friend drilled a field of barley, at the rate, not of 5, but 1½ bushels of seed per acre, and reared, notwithstanding, a full and fair average crop, and the calculation is that 12 shillings per acre for wheat and 10 shillings for barley may be saved on all the arable land in the country, placed under these descriptions of crop. Something, too, is gained in appearance: a succession of rows beautifully straight has a pleasing effect, and the opinion gains ground, that wheat thus raised will be easier reaped, and less liable to be lodged during wet weather. It is difficult to describe machinery in the absence of cuts; and all we say is, that the weight of the plough, by pressing on a wheel connected with the seed chest, causes it to revolve, and opens the valves with the greatest regularity. A small coulter cuts the soil to the proper width and depth, and no more; and two iron teeth, like the teeth of harrows, cover up the tiny drill, and complete the operation. From the position of the seed-box, nothing is trodden under foot: by reason of the wheel below the plough, the task of the horses is not harder than in ordinary cases, and a man, or even a lad, can plough, sow, and harrow, at the rate of one acre per day, or more. From the great breadth of oats planted, and the necessity which exists of breaking the stubborn glebe during winter, broadcasting this description of crop must still remain the favorite mode of husbandry; while, on the other hand, wheat and barley, from the success of the experiments already made, must, ere long, be drilled almost universally. By modifying the seed-chest and substituting one for another, according to the nature of the operation, potatoes may be planted, and beans

and peas sown on the same principle. By means of an index, the quantity of seed required to be sown is regulated with mathematical accuracy, and can be increased or diminished according to circumstances.—[Dumfries Courier.]

History of Chemistry. [Continued from page 43.]

SILVER.—Silver was known to the nations of antiquity. Its discovery is of an earlier date than the most ancient records of mankind; and it soon became, by its scarcity, its beauty, and its useful properties, the object of the researches of a great number of artists and men of science. It is not astonishing that men who had caused the metallic substances to assume so many different forms, and who so frequently imitated by alloys the whiteness and several of the properties of silver, harbored from a very remote period the idea of creating this precious metal by art. When they compared it with the other white metals, it seemed to them to differ from them only in some qualities, and that it would not be impossible to procure it free from those qualities. Not discouraged by their first unsuccessful attempts, in proportion as this precious metal became amongst mankind the representative of all other objects, of all the productions of industry, and even of those of genius, the alchemists redoubled their efforts; and though their experiments and their laborious researches have not had all the success which they expected from them, they have not been entirely lost. It is from these unfortunate trials, accumulated by the labors of ages, that chemists have derived the facts which they have employed in its history; and they have had, as it were, nothing more to do than to arrange, in a methodical order, and clearly to describe, the phenomena which this metal had presented, in the tortures of every kind to which alchemists have subjected it.

Whilst the alchemists, who called silver *Luna* or *Diana*, qualified it even by the sign which they consecrated it to, as a kind of semi-gold, which they represented by two semi-circular lines put together in the same direction, with the horns turned to the left; so that nothing more was necessary than to turn back the interior curve, and unite it with the exterior in order to form the circular figure, or characteristic sign of gold, to which they believed it to be, in fact, very nearly related, since it was only required to develope one of its parts, in order to cause it to pass into the state of gold, the last stage of metallic perfection. The labors of the alchemists have extended its numerous uses, and have been no less useful to the chemists in constructing the system of their science. The pharmaceutical operations themselves, though they have been much less numerous upon silver than upon many other metals, have served to increase the stock of chemical knowledge concerning this metal; and it is from the whole of these labors that the history of this important metal has gradually been formed.

Silver is of a fine white color, and of an extremely lively brilliancy. Whether burnished or otherwise, this metal is the most beautiful that is known, at least in the opinion of most men. In general, it pleases more than any other metallic substance. There is no metal that approaches it in lustre; it holds only the fifth rank amongst the metals with respect to density and specific gravity; it follows after platina, gold, tungsten, mercury, and lead. Its specific gravity is 10·474 when melted, and 10·535 when hammered.

With respect to its hardness, it has been placed between iron and gold; this is, however, augmented by the action of the hammer, or by pressure. Its elasticity is pretty considerable; and in this respect it is intermediate between gold and copper. It is one of the most sonorous metals, and when struck it emits a very acute sound.

The ductility of silver is one of its most marked properties; it follows immediately after gold and platina. It is made into leaves so thin, that they are easily wafted away by the wind, and into wires of extreme tenuity. On this account it is instanced in Natural Philosophy to prove the divisibility of matter. A grain of silver may be sufficiently extended, and at the same time sufficiently firm to make an hemispherical vessel to contain an ounce of water, or a wire 400 feet in length. It is upon this amazing malleability that the art of gold and silver beating is founded. It holds the second rank after gold, with respect to tenacity, or resistance against breaking. A wire of this metal, one tenth of an inch in diameter, supports a weight of 270 pounds before it breaks. This wire is considerably lengthened before it breaks. Silver is hardened by all kinds of pressure; but it easily acquires its former ductility again by the action of fire, or by annealing.

Silver is a very good conductor of caloric, and becomes heated very quickly. Its expansion by heat is a little inferior to that of lead and tin, and superior to that of iron. When silver has been expanded by heat, and the fire urged till it is heated to white-

ness or incandescence, it softens and runs. Its fusibility has been estimated by Mortimer at 1600 degrees of Fahrenheit. When silver has been fused and suffered to cool slowly, it presents at its surface figures similar to net-work and fern leaves, which announce a very marked crystallizability. On breaking it we find a granulated texture, which possesses the same property. Mongez and Tillet, by suffering a liquid portion to run off from a large mass of fused silver, have obtained it crystallized in quadrangular or octahedral prisms; and it affects the same form in nature, as will be afterwards noticed.

Silver is a very good conductor of electricity and galvanism. It has no sensible taste nor smell; neither does it produce any effect upon the animal economy; and though it cannot be considered as dangerous to the health, it must, nevertheless, be reckoned amongst the number of perfectly inert substances destitute of any medicinal property.

Nature presents silver neither in such abundance, nor in so many places, nor in such large masses, as most of the other metallic substances. Even the number of species that can be distinguished amongst the ores of this metal is infinitely more limited than these which are admitted in most of the other metals. The mineralogists, who have hitherto considered its varieties as species, have moreover committed another error, namely, that of having too closely followed the errors and prejudices of the miners. These considering as ores of silver all those ores that are capable of affording this precious metal, of whatever nature they may be, which have very much obscured the natural history of this metal.

Pure silver, when exposed to the air, remains in it without alteration, except with respect to its polish and brilliancy; it becomes less shining and a little tarnished at its surface, but without being oxidized. We ought not, however, to confound the kind of covering or stratum of a deep blue color, which is formed upon old silver plate exposed for a long time to the contact of several gases mixed with the air, with a stratum which, according to the examination of it instituted by Mr. Proust, is merely a sulphuret of this metal. Silver has long been believed to be perfectly indestructible by the contact of the air, even when aided by a very intense heat; and on this account it was ranked amongst the perfect metals. Several chemists, and especially Junker, had advanced, that by treating silver by a long reverberation, and in a furnace where the flame circulated above the metal, the silver was at last converted into a vitriform oxide. It has even been added, that when united with mercury, and divided by this liquid metal, it was oxidized by the processes which are usually employed for converting mercury into red oxide, and which is not improbable.

Many experiments made since the assertion of Junker, and by different processes, have proved that silver is really oxidizable, but only that it is much less so, and with much greater difficulty, than the other metals. Macquer was the first who remarked this oxidation, by exposing silver in a crucible to the intense heat of the furnace of Sevres twenty successive times. At the last time, very sensible traces of oxidation were perceived, and a vitrification of an olive color. Macquer never failed to observe, when treating silver in the focus of a burning glass, that after a long incandescence, it became covered with a white powder which formed a stratum upon the support of the silver. Homberg, in the first experiments with the burning glass of Tchirshausen, had made the same observations upon silver and upon gold. It cannot be doubted that these facts indicate a marked oxidation of the silver, and that they become more strong and conclusive when joined with the experiments which we shall mention.

Van Marum made many valuable researches respecting the effects of electricity with the grand machine of Teyler, and found that it took fire and burned. By passing the electric shock from a battery through a wire of this metal, the wire is suddenly reduced, as it were, into powder, with a greenish white flame, which passes with the rapidity of lightning, and the oxide manifestly formed in this operation is dissipated in smoke. If we perform the same operation by wrapping up the wire, or fixing it upon white paper, it attaches itself to it in a very fine powder of a greenish grey color, so fine and so adherent, that it resembles smoke, or a light covering which cannot be separated from it again. It is impossible here to doubt either of the state of oxidation of the silver, or of its combustibility; because the phenomenon is constantly accompanied with flame. We may attribute this effect, which is not produced by ordinary fire, however intense it may be, to the extreme division of the metal by the electric shock, and to the high temperature produced by the electric composition in the body which is exposed to it. A stroke of lightning upon silver wires and silver furniture produces exactly the same phenomena, and is followed by the same results.

The oxide of silver formed by these dif-

ferent processes, and which is so difficult to be obtained, is likewise extremely easy of reduction, because the silver adheres to the oxygen very weakly. Though the presence of this body augments its weight, changes its properties, and especially renders it acrid and caustic, nothing more is required than to expose these greenish or yellowish grey oxides to the contact of the solar rays, in order to make them assume a darker color, become black, and approach to the metallic state. When we heat them in close vessels, and with the pneumatic apparatus, we obtain from them pure oxygen gas, and easily convert them into the brilliant and ductile metal, by fusing them in a crucible.

Neither carbon nor hydrogen have been combined with silver; but it combines readily with sulphur and phosphorus.

It is well known, that when silver is long exposed to the air, especially in frequented places, as churches, theatres, &c. it acquires a covering of a violet color, which deprives it of its lustre and malleability. This covering, which forms a thin layer, can only be detached from the silver by bending it, or breaking it in pieces with a hammer. It was examined by Mr. Proust, and found to be *sulphuret of silver*.

Silver does not combine with the simple incombustibles.

Silver combines readily with the greater number of metallic bodies.

When silver and gold are kept melted together, they combine and form an alloy, composed, as Homberg ascertained, of one part of silver and five of gold. He kept equal parts of gold and silver in gentle fusion for a quarter of an hour, and found, on breaking the crucible, two masses, the uppermost of which was pure silver, the undermost the whole gold combined with $\frac{1}{5}$ of silver. Silver, however, may be melted with gold in almost any proportion; and if the proper precautions be employed, the two metals remain combined together.

The alloy of gold and silver is harder and more sonorous than gold. Its hardness is a maximum when the alloy contains two parts of gold and one of silver. The density of these metals is a little diminished, and the color of the gold is much altered, even when the proportion of the silver is small; one part of silver produces a sensible change in twenty parts of gold. The color is not only pale, but it has also a very sensible greenish tinge, as if the light reflected by the silver passed through a very thin covering of gold. This alloy, being more fusible than gold, is employed to solder pieces of that metal together.

When silver and platinum are fused together, (for which a very strong heat is necessary,) they form a mixture, not so ductile as silver, but harder, and less white. The two metals are separated by keeping them for some time in the state of fusion; the platinum sinking to the bottom from its weight. This circumstance would induce one to suppose that there is very little affinity between them. Indeed, Dr. Lewis found that, when the two metals were melted together, they sputtered up as if there were a kind of repugnance between them. The difficulty of uniting them was noticed also by Scheffer.

Of Palladium.—This metal was first found by Dr. Wollaston combined with platina, among the grains of which he supposes its ore to exist, or an alloy of it with iridium and osmium, scarcely distinguishable from the crude platina, though it is harder and heavier. Palladium is of a greyish white color, scarcely distinguishable from platina, and takes a good polish. It is ductile and very malleable; and being reduced into thin slips, is flexible, but not very elastic. Its fracture is fibrous, and in diverging striæ, showing a kind of crystalline arrangement. In hardness it is superior to wrought iron. Its specific gravity is from 10·9 to 11·8. It is a less perfect conductor of caloric than most metals, and less expansible, though in this it exceeds platina. On exposure to a strong heat, its surface tarnishes a little, and becomes blue; but an increased heat brightens it again. It is reducible *per se*. Its fusion requires a much higher heat than that of gold; but if touched while hot with a small bit of sulphur, it runs like zinc. The sulphuret is whiter than the metal itself, and extremely brittle.

Nitric acid soon acquires a fine red color from palladium, but the quantity it dissolves is small. Nitrous acid acts on it more quickly and powerfully. Sulphuric acid, by boiling, acquires a similar color, dissolving a small portion. Muriatic acid acts much in the same manner. Nitro-muriatic acid dissolves it rapidly, and assumes a deep red.

Alkalies and earths throw down a precipitate from its solutions generally of a fine orange color; but it is partly re-dissolved in an excess of alkali. Some of the neutral salts, particularly those of potash, form with it triple compounds, much more soluble in water than those of platina, but insoluble in alcohol.

Alkalies act on palladium even in the metallic state; the contact of air, however, promotes their action.

A neutralized solution of palladium is precipitated of a dark orange or brown co-

ler by recent muriate of tin; but if it be in such proportions as to remain transparent, it is changed to a beautiful emerald green. Green sulphate of iron precipitates the palladium in the metallic state. Sulphuretted hydrogen produces a dark brown precipitate; prussiate of potash, an olive colored; and prussiate of mercury, a yellowish white. As the last does not precipitate platina, it is an excellent test of palladium. This precipitate is from a neutral solution in nitric acid, and detonates at about 500° Fahr., in a manner similar to gunpowder. Fluoric, arsenic, phosphoric, oxalic, tartaric, citric, and some other acids, with their salts, precipitate some of the solutions of palladium.

When strongly heated, its surface assumes a blue color; but by increasing the temperature, the original lustre is again restored. This blue color is doubtless a commencement of oxidizement; but neither the properties of the oxides of this metal, nor the proportion of oxygen with which it combines, have been ascertained.

The effect of hydrogen upon palladium has scarcely been tried. Chenevix melted the metal in a charcoal crucible, but it was not in the least altered.

Palladium unites very readily to sulphur. When it is strongly heated the addition of a little sulphur causes it to run into fusion immediately, and the sulphuret continues in a liquid state till it be only obscurely red hot. Sulphuret of palladium is rather paler than the pure metal, and is extremely brittle. By means of heat and air the sulphur may be gradually dissipated, and the metal obtained in a state of purity.

Azote has probably no effect upon it; but muriatic acid produces its oxidizement, and forms a red solution with the oxide.

The Cheap Transportation of Books and Periodicals.—The present state of society demands a cheap system of conveyance for the diffusion of knowledge. The post-office system is too expensive. On this system conveyance must be more expensive, from its rapidity, than is necessary for all purposes. A vast number of publications now issued are not required to be transmitted with great speed. As mail stages now usually run, they carry a load of one thousand pounds at three times the expense of conveying the same load at a moderate rate. "In England," says the Scientific Tract on Railroads, "every coach on the best roads that runs for twenty-four hours, at nine miles per hour, drawing not over two tons, requires no less than 180 horses, or ninety each way. Less than 12 horses would carry the same weight for the same time, at two and a half miles per hour." In the mail stages of our country, weighing about a ton, less than a ton of passengers and baggage is usually carried. To transport this load at the rate ordinarily travelled, the horses are changed every twelve miles. To carry the load, therefore, thirty-six miles, twelve horses are needed. At the rate of four miles an hour, four horses would transport this load in waggons. At a moderate speed, therefore, a load of magazines and books would be conveyed at one third the cost of transportation by rapid mail stages. But there is no advantage in my having many of the periodicals I receive by a rapid conveyance. A system of baggage waggons, transporting small articles over the country at a cheap rate, would, therefore, greatly facilitate the diffusion of knowledge. I wish to take the Biblical Repository, and find that four numbers weigh two pounds and ten ounces. I live rather more than 100 miles from Boston; and the postage of the whole, comprising 50 sheets, would be $1.25; while the freight, at the rate at which goods are commonly transported in waggons, would be a little less than 2½ cents. The postage of forty numbers of the Temperance Recorder would be 60 cents; while the freight of the whole 40, if the papers were dried, and thus made light, would not be more than one cent. When the post-office was established there did not exist such a periodical literature as distinguishes the present age; and therefore, the United States did not provide for such a conveyance of packets as is now needed. The law now in force, passed March, 1827, enacts, "That no person, other than the Postmaster General, or his authorized agents, shall set up any foot or horse post for the conveyance of letters and packets upon any post road, which is or may be established as such by law." This law forbids such a system of conveyance of parcels as is contemplated in this article, unless it should be established by the post-office department. But if it should not be thus established, it may be authorised by act of Congress. Why should booksellers and printers, and publishers, be shackled in their business more than other classes of the community? A vast amount of the literature of the country is now periodical. We have our weeklies, our monthlies, our quarterlies, and our annuals, without number. We have our libraries too; the Christian's Library, the Select Circulating Library, and a variety of others. It is desirable that there should be a regular and cheap conveyance of such books. This difficulty of dis-

tributing periodicals over the country is of the nature of a heavy duty on them. The postage on a periodical, which does not convey news, and needs not to be carried post haste, now greatly increases its cost, and checks its circulation. If shoes, and hats, and other articles of manufacture, could be conveyed only by government lines, at the cost of 33 per cent. on their value, the manufacturers would be exceedingly embarrassed; and the public, too, would be injured beyond calculation, especially if the manufacture could be carried on only in one place in a whole county, or in a whole state, as is the case with books and periodicals.—[Scientific Tracts and Lyceums.]

Animal Mechanics, or Proofs of Design in the Animal Frame. Continued from page 9. [From the Library of Useful Knowledge.]

Fig. 5.

By all this, we see that if the skull is to be considered as an arch, and the parietal bones as forming that arch, they must be secured at the temporal and sphenoid* bones, the points from which they spring. And, in point of fact, where is it that the skull yields when a man falls, so as to strike the top of his head upon the ground?—in the temples. And yet the joinings are so secure, that the extremity of the bone does not start from its connections. It must be fractured before it is spurred out, and in that case only does the upper part of the arch yield.

But the best illustration of the form of the head is the dome.

A dome is a vault rising from a circular or elliptical base; and the human skull is, in fact, an elliptical surmounted dome, which latter term means that the dome is higher than the radius of its base. Taking this matter historically, we should presume that the dome was the most difficult piece of architecture, since the first dome erected appears to have been at Rome, in the reign of Augustus—the Pantheon—which is still entire. The dome of St. Sophia, in Constantinople, built in the time of the emperor Justinian, fell three times during its erection: and the dome of the cathedral of Florence stood unfinished 120 years for want of an architect. Yet we may, in one sense, say that every builder who tried it, as well as every laborer employed, had the most perfect model in his own head. It is obvious enough, that the weight of the upper part of the dome must disengage the stones from each other which form the lower circle, and tend to break up their joinings, and consequently to press or thrust outwards the circular wall on which it rests. No walls can support the weight, or rather, the lateral thrust, unless each stone of the dome be soldered to another, or the whole hooped together and girded. The dome of St. Paul's has a very strong double iron chain, linked together, at the bottom of the cone; and several other lesser chains between that and the cupola, which may be seen in the section of St. Paul's engraved by Hooker.

The bones of the head are securely bound together, so that the anatomist finds, when every thing is gone, save the bone itself, and there is neither muscle, ligament, nor membrane of any kind to connect the bones, they are still securely joined, and it requires his art to burst them asunder; and for this purpose he must employ a force which shall produce a uniform pressure from the centre outwards; and all the sutures must receive the pressure at one time, and equally, or they will not give way. And now is the time to observe another circumstance, which calls for our admiration. So little of accident is there in the joining of the bones, that the edge of a bone at the suture lies over the adjoining bones at one part, and under it at another, which, with the dovetailing of the suture, as before described, holds each bone in its place firmly attached; and it is this which gives security to the dome of the cranium.

If we look at the skull in front, we may consider the orbits of the eye as crypts under the greater building. And these under arches are groined, that is to say, there are

* In the Greek, sphenoid—in the Latin, cuneiform—like a wedge, because it is wedged among the other bones of the head; but these processes, called wedges, are more like dovetails, which enter into the irregularities of the bones, and hold them locked.

strong arched spines of bone, which give strength sufficient to permit the interstices of the groinings, if I may so term them, to be very thin. Betwixt the eye and the brain, the bone is as thin as parchment; but if the anterior part of the skull had to rest on this, the foundation would be insufficient. This is the purpose of the strong ridge of bone which runs up like a buttress from the temple to the lateral part of the frontal bone, whilst the arch forming the upper part of the orbit is very strong; and these ridges of bone, when the skull is formed with what we call a due regard to security, give an extension to the forehead.*

In concluding this survey of the architecture of the head, let us suppose it so expanded that we could look upon it from within. In looking up to the vault we should at once perceive the application of the *groin* in masonry; for the groin is that projection in the vault which results from the intersection of two arches running in different directions. One rib or groin extends from the centre of the frontal bone to the most projecting part of the occipital foramen, or opening on the back of the head; the other rib crosses it from side to side of the occipital bone. The point of intersection of these two groins is the thickest and strongest part of the skull, and it is the most exposed, since it is the part of the head which would strike upon the ground when a man falls backwards.

What is termed the base of the skull is strengthened, if we may so express it, on the same principle: it is like a cylinder groin, where the rib of an arch does not terminate upon a buttress or pilaster, but is continued round in the completion of the circle. The base of the skull is irregular, and in many places thin and weak, but these arched spines or ribs give it strength to bear those shocks to which it is of course liable at the joining of the skull with the spine.

CHAPTER II.

Mechanism of the Spine.—The brain case is thus a perfect whole, secure on all sides, and strengthened where the exposure to injury is the greatest. We shall see, in the column which sustains it, equal provision for the security of the brain; and what is most admirable, there is an entirely different principle introduced here; for whereas, in the head, the whole aim is firmness in the joinings of the bones, in the spine which supports the head the object to be attained is mobility or pliancy. In the head, each bone is firmly secured to another; in the spine, the bones are not permitted to touch; there is interposed a soft and elastic material, which takes off the jar that would result from the contact of the bones. We shall consider this subject a little more in detail.

The spinal column, as it is called, serves three purposes: it is the great bond of union betwixt all the parts of the skeleten; it forms a tube for the lodgment of the spinal marrow, a part of the nervous system as important to life as the brain itself; and lastly, it is a column to sustain the head.

We now see the importance of the spine, and we shall next explain how the various offices are provided for.

If the protection of the spinal marrow had been the only object of this structure, it is natural to infer that it would have been a strong and unyielding tube of bone; but as it must yield to the inflexions of the body, it cannot be constituted in so strict an analogy with the skull. It must, therefore, bend; but it must have no abrupt or considerable bending at one part, for the spinal marrow within would in this way suffer.

By this consideration we perceive why there are twenty-four bones in the spine, each bending a little; each articulated or making a joint with its fellow; all yielding in a slight degree, and, consequently, permitting in the whole spine that flexibility necessary to the motions of the body. It is next to be observed, that whilst the spine by this provision moves in every direction, it gains a property which it belongs more to our present purpose to understand. The bones of the spine are called vertebræ; at each interstice between these bones, there is a peculiar grisly substance, which is squeezed out from betwixt the bones, and, therefore, permits them to approach and play a little in the motions of the body. This grisly substance is inclosed in an elastic binding, or membrane of great strength, which passes from the edge or border of one vertebra to the border of the one next it. When a weight is upon the body, the soft gristle is pressed out, and the membrane yields: the moment the weight is removed, the membranes recoil by their elasticity, the gristle is pressed into its place, and the bones resume their position.

We can readily understand how great the influence of these twenty-four joinings must be in giving elasticity to the whole column; and how much this must tend to the protection of the brain. Were it not for this interposition of elastic material, every motion of the body would produce a jar to the deli-

* Although they are solid arches connected with the building of the cranium, and bear no relation to the surfaces of the brain, the early craniologists would have persuaded us that their forms correspond with the surfaces of the brain, and indicate particular capacities or talents.

cate texture of the brain, and we should suffer almost as much in alighting on our feet as in falling on our head. It is, as we have already remarked, necessary to interpose thin plates of lead or slate between the different pieces of a column, to prevent the edges (technically called arrises) of the cylinders from coming in contact, as they would in that case chip or split off.

But there is another very curious provision for the protection of the brain: we mean the curved form of the spine. If a steel spring, perfectly straight, be pressed betwixt the hands from its extremities, it will resist, notwithstanding it elasticity, and when it does give way, it will be with a jerk.

Such would be the effect on the spine if it stood upright, one bone perpendicular to another, for then the weight would bear equally; the spine would yield neither to one side nor to the other, and consequently there would be a resistance from the pressure on all sides being balanced. We, therefore, see the great advantage resulting from the human spine being in the form of an italic *f*. It is prepared to yield in the direction of its curves; the pressure is of necessity more upon one side of the column than on the other; and its elasticity is immediately in operation without a jerk. It yields, recoils, and so forms the most perfect spring; admirably calculated to carry the head without jar or injury of any kind.

The most unhappy illustration of all this is the condition of old age. The tables of the skull are then consolidated, and the spine is rigid: if an old man should fall with his head upon the carpet, the blow, which would be of no consequence to the elastic frame of a child, may to him prove fatal; and the rigidity of the spine makes every step which he takes vibrate to the interior of the head, and jar on the brain.

We have hinted at a comparison betwixt the attachment of the spine to the pelvis and the insertion of the mast of a ship into the hull. The mast goes directly through the decks without touching them, and the heel of the mast goes into the step, which is formed of large solid pieces of oak timber laid across the keelson. The keelson is an inner keel, resting upon the floor-timbers of the ship, and directly over the proper keel. These are contrivances for enlarging the base on which the mast rests as a column: for as, in proportion to the height and width of a column, its base must be enlarged, or it would sink into the earth, so, if the mast were to bear upon a point, it would break through the bottom of the ship.

The mast is supported upright by the shrouds and stays. The shrouds secure it against the lateral or rolling motion, and the stays and backstays against the pitching of the ship. These form what is termed the standing rigging. The mast does not bear upon the deck or on the beams of the ship; indeed, there is a space covered with canvas betwixt the deck and the mast.

We often hear of a new ship going to sea to stretch her rigging; that is, to permit the shrouds and stays to be stretched by the motion of the ship, after which they are again braced tight; for if she were overtaken by a storm before this operation, and when the stays and shrouds were relaxed, the mast would lean against the upper deck, by which it would be sprung or carried away. Indeed, the greater proportion of masts that are lost are lost in this manner. There are no boats which keep the sea in such storms as those which navigate the Gulf of Finland. Their masts are not attached at all to the hull of the ship, but simply rest upon the step.

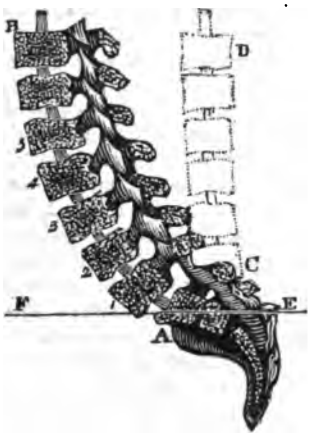
Although the spine has not a strict resemblance to the mast, the contrivances of the ship-builder, however different from the provisions of nature, show what object is to be attained; and when we are thus made aware of what is necessary to the security of a column on a moveable base, we are prepared to appreciate the superior provisions of nature for giving security to the human spine.

The human spine rests on what is called the *pelvis*, or basin: a circle of bones, of which the haunches are the extreme lateral parts; and the sacrum, (which is as the key-stone of the arch) may be felt at the lower part of the back. To this central bone of the arch of the pelvis, the spine is connected; and, taking the similitude of the mast, the sacrum is the *step* on which the base of the pillar, like the heel of the mast, is socketed or morticed. The spine is tied to the lateral parts of the pelvis by powerful ligaments, which may be compared to the shrouds. They secure the lower part of the spine against the shock of lateral motion or rolling; but instead of the stays, to limit the play of the spine forwards and backwards in pitching, or to adjust the rake of the mast, there is a very beautiful contrivance in the lower part of the column.

The spine forms here a semi-circle, which has this effect: that, whether by the exertion of the lower extremities, the spine is to be carried forward upon the pelvis, or whether the body stops suddenly in running, the jar which would necessarily take place at the lower part of the spine, A, if it stood

upright like a mast, is distributed over several of the bones of the spine, 1, 2, 3, 4, and, therefore, the chance of injury at any particular part is diminished.

Fig. 6.



For example, the sacrum, or centre bone of the pelvis, being carried forward, as when one is about to run, the force is communicated to the lowest bone of the spine. But then the surfaces of these bones stand with a very slight degree of obliquity to the line of motion; the shock communicated from the lower to the second bone of the vertebræ is still in a direction very nearly perpendicular to its surface of contact. The same takes place in the communication of force from the second to the third, and from the third to the fourth; so that before the shock of the horizontal motion acts upon the perpendicular spine, it is distributed over four bones of that column, instead of the whole force being concentrated upon the joinings of any two, as at A.

If the column stood upright, as indicated at C D, it would be jarred at the lowest point of contact with its base. But by forming a semi-circle A B, the motion which, in the direction E F, would produce a jar on the very lowest part of the column, is distributed over a considerable portion of the column A B; and, in point of fact, this part of the spine never gives way. Indeed, we should be inclined to offer this mode to the consideration of nautical men, as fruitful in hints for improving naval architecture.

Every one who has seen a ship pitching in a heavy sea, must have asked himself why the masts are not upright, or rather why the foremast stands upright, whilst the main and mizen masts stand oblique to the deck, or, as the phrase is, rake aft, or towards the stern of the ship.

The main and mizen masts incline backwards, because the strain is greatest in the forward pitch of the vessel; for the mast having received an impulse forwards, it is suddenly checked as the head of the ship rises; but the mast being set with an inclination backwards, the motion falls more in the perpendicular line from the head to the heel. This advantage is lost in the upright position of the foremast, but it is sacrificed to a superior advantage gained in working the ship; the sails upon this mast act more powerfully in swaying the vessel round, and the perpendicular position causes the ship to tack or stay better; but the perpendicular position, as we have seen, causes the strain in pitching to come at right angles to the mast, and is, therefore, more apt to spring it.

These considerations give an interest to the fact that the human spine, from its utmost convexity near its base, inclines backwards.

CHAPTER III.

Of the Chest.—In extending the parallel which we proposed between the structure of the body and the works of human art, it signifies very little to what part we turn; for the happy adaptation of means to the end will every where challenge our admiration, in exact proportion to our success in comprehending the provisions which Supreme Wisdom has made. We turn now to a short view of the bones of the chest.

The thorax, or chest, is composed of bones and cartilages, so disposed as to sustain and protect the most vital parts, the heart and lungs, and to turn and twist with perfect facility in every motion of the body; and to be in incessant motion in the act of respiration, without a moment's interval during a whole life. In anatomical description, the thorax is formed of the vertebral column, or spine, on the back part, the ribs on either side, and the breast bone, or sternum, on the fore part. But the thing most to be admired is the manner in which these bones are united, and especially the manner in which the ribs are joined to the breast bone, by the interposition of cartilages or gristle, of a substance softer than bone, and more elastic and yielding. By this quality they are fitted for protecting the chest against the effects of violence, and even for sustaining life after the muscular power of respiration has become too feeble to continue without this support.

If the ribs were complete circles, formed of bone, and extending from the spine to the breast bone, life would be endangered by any accidental fracture; and even the rubs and jolts to which the human frame is

continually exposed, would be too much for their delicate and brittle texture. But these evils are avoided by the interposition of the elastic cartilage. On their fore part the ribs are eked out, and joined to the breast bone by means of cartilages, of a form corresponding to that of the ribs, being, as it were, a completion of the arch of the ribs, by a substance more adapted to yield in every shock or motion of the body. The elasticity of this portion subdues those shocks which would occasion the breaking of the ribs. We lean forward, or to one side, and the ribs accommodate themselves, not by a change of form in the bones, but by the bending or elasticity of the cartilages. A severe blow upon the ribs does not break them, because their extremities recoil and yield to the violence. It is only in youth, however, when the human frame is in perfection, that this pliancy and elasticity have full effect. When old age approaches, the cartilages of the ribs become bony. They attach themselves firmly to the breast bone, and the extremities of the ribs are fixed, as if the whole arch were formed of bone unyielding and inelastic. Then every violent blow upon the side is attended with fracture of the rib, an accident seldom occurring in childhood, or in youth.

But there is a purpose still more important to be accomplished by means of the elastic structure of the ribs, as partly formed of cartilage. This is in the action of breathing, or respiration; especially in the more highly-raised respiration which is necessary in great exertions of bodily strength, and in violent exercise. There are two acts of breathing—*expiration*, or the sending forth of the breath, and *inspiration*, or the drawing in of the breath. When the chest is at rest, it is neither in the state of expiration nor in that of inspiration; it is in an intermediate condition between these two acts. And the muscular effort by which either inspiration or expiration is produced, is an act in opposition to the elastic property of the ribs. The property of the ribs is to preserve the breast in the intermediate state between expiration and inspiration. The muscles of respiration are excited alternately, to dilate or to contract the cavity of the chest, and, in doing so, to raise or to depress the ribs. Hence it is, that both in inspiration and in expiration, the elasticity of the ribs is called into play; and, were it within our province, it would be easy to show that the dead power of the cartilages of the ribs preserve life by respiration, after the vital muscular power would, without such assistance, be too weak to continue life.

It will at once be understood, from what has now been explained, how, in age, violent exercise or exertion is under restraint, in so far as it depends on respiration. The elasticity of the cartilages is gone, the circle of the ribs is now unyielding and will not allow that high breathing, that sudden and great dilating and contracting of the cavity of the chest, which is required for circulating the blood through the lungs, and relieving the heart amidst the more tumultuous flowing of the blood which exercise and exertion produce.

CHAPTER IV.

Design shown in the Structure of the Bones and Joints of the Extremities.—That the bones which form the interior of animal bodies should have the most perfect shape, combining strength and lightness, ought not to surprize us, when we find this in the lowest vegetable production.

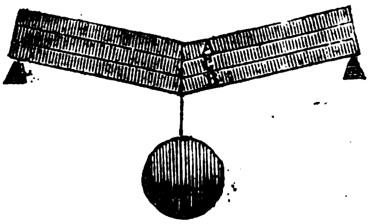
In the sixteenth century, an unfortunate man who taught medicine, philosophy, and theology, was accused of atheistical opinions, and condemned to have his tongue cut out, and to suffer death. When brought from his cell before the inquisition, he was asked if he believed in God. Picking up a straw which had stuck to his garments, "If," said he, "there was nothing else in Nature to teach me the existence of a Deity, even this straw would be sufficient?"

A reed, or a quill, or a bone, may be taken to prove that in Nature's works strength is given with the least possible expense of materials. The long bones of animals are, for the most part, hollow cylinders, filled up with the lightest substance, marrow; and in birds the object is attained by means (if we may be permitted to say so) still more artificially. Every one must have observed, that the breast bone of a fowl extends along the whole body, and that the body is very large compared with the weight; this is for the purpose of rendering the creature specifically lighter, and more buoyant in the air; and that it may have a surface for the attachment of muscles, equal to the exertion of raising it on the wing. This combination of lightness with increase of volume is gained by air cells extending through the body, and communicating by tubes between the lungs and cavities of the bones. By these means the bones, although large and strong, to withstand the operation of powerful muscles upon them, are much lighter than those of quadrupeds.

The long bones of the human body being hollow tubes, are called cylindrical, though they are not accurately so, the reason of which we shall presently explain; and we

shall at the same time show that their irregularities are not accidental, as some have imagined. But let us first demonstrate the advantage which, in the structure of the bones, is derived from the cylindrical form, or a form approaching to that of the cylinder. If a piece of timber, supported on two points, thus—

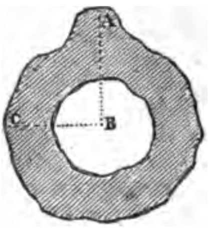
Fig. 7.



bearing a weight upon it, it sustains this weight by different qualities in its different parts. For example, divide it into three equal parts (A, B, C,): the upper part, A, supports the weight by its solidity and resistance to compression; the lowest part, B, on the other hand, resists by its toughness, or adhesive quality. Betwixt the portions acting in so different a manner, there is an intermediate neutral, or central part, C, that may be taken away without materially weakening the beam, which shows that a hollow cylinder is the form of strength. The writer lately observed a good demonstration of this: a large tree was blown down, and lay upon the ground; to the windward, the broken part gaped; it had been torn asunder like the snapping of a rope. To the leeward side of the tree, the fibres of the stem were crushed into one another and splintered, whilst the central part remained entire. This, we presume, must be always the case, more or less; and here we take the opportunity of noticing why the arch is the form of strength. If this transverse piece of timber were in the form of an arch, and supported at the extremities, then its whole thickness, its centre, as well as the upper and lower parts, would support weight by resisting compression. But the demonstration may be carried much farther to show the form of strength in the bone. If the part of the cylinder which bears the pressure be made more dense, the power of resistance will be much increased; whereas, if a ligamentous covering be added on the other side, it will strengthen the part which resists extension, and we observe a provision of this kind in the tough ligaments which run along the vertebræ of the back.

When we see the bone cut across, we are forced to acknowledge that it is formed on the principle of the cylinder; that is, that the material is removed from the centre, and accumulated on the circumference, thus:

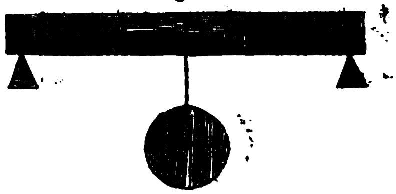
Fig. 8.



We find a spine or ridge running along the bone, which, when divided by the saw in a transverse direction, exhibits an irregularity, as at A.

The section of this spine shows a surface as dense as ivory, which is, therefore, much more capable of resisting compression than the other part of the cylinder, which is common bone. This declares what the spine is, and the anatomists must be wrong who imagine that the bone is moulded by the action of the muscle, and that the spine is a mere ridge, arising by accident among the muscles. It is, on the contrary, a strengthening of the bone in the direction on which the weight bears. If we resume the experiment with the piece of timber, we shall learn why the spine is harder than the rest of the bone. If a portion of the upper part of the timber be cut away, and a harder wood inserted in its place, the beam will acquire a new power of resisting fracture, because, as we have stated, this part of the wood does not yield but by being crushed, and the insertion of the harder portion of wood increases this

Fig. 9.



property of resistance. With this fact before us, we may return to the examination of the spine of bone. We see that it is calculated to resist pressure: first, because it is farther removed from the centre of the cylinder, and, secondly, because it is denser, to resist compression, than the other part of the circumference of the bone.*

* As the line A B extends farther from the centre than B C, on the principle of a lever, the resistance to transverse fracture will be greater in the direction A B than B C.

This explanation of the use of a spine upon a bone gives a new interest to osteology.* The anatomists ought to deduce from the form of the spine the motions of the limb; the forces bearing upon the bone, and the nature and the common place of fracture; while, to the general inquirer, an agreeable process of reasoning is introduced in that department, which is altogether without interest when the "*irregularities*" of the bone are spoken of, as if they were the accidental consequences of the pressure of the flesh upon it.

Although treating of the purely mechanical principle, it is, perhaps, not far removed from our proper object to remark, that a person of feeble texture and indolent habits has the bone smooth, thin, and light; but that Nature, solicitous for our safety, in a manner which we could not anticipate, combines with the powerful muscular frame a dense and perfect texture of bone, where every spine and tubercle is completely developed. And thus the inert and mechanical provisions of the bone always bear relation to the muscular power of the limb, and exercise is as necessary to the perfect constitution of a bone as it is to the perfection of the muscular power. Jockies speak correctly enough when they use the term "*blood and bone,*" as distinguishing the breed or genealogy of horses; for blood is an allowable term for the race, and bone is so far significant, that the bone of a running horse is remarkably compact compared with the bone of a draught horse. The reader can easily understand that the span in the gallop must give a shock in proportion to its length; and, as in man, so in the horse, the greater the muscular power the denser and stronger is the bone.

The bone not being as a mere pillar, intended to bear a perpendicular weight, we ought not to expect uniformity in its shape. Each bone according to its place bears up against the varying forces that are applied to it.

Wonders of Art.—You behold a majestic vessel bounding over the billows from the other side of the globe; easily fashioned to float with safety over the bottomless sea; to spread out her broad wings, and catch the midnight breeze, guided by a slow drowsy sailor at the helm, with two or three companions reclining listlessly on the deck, gazing into the depths of the starry heavens. The commander of this vessel, not surpassing thousands of his brethren in intelligence and skill, knows how, by pointing his glass at the heavens, and taking an observation of the stars, and turning over the leaves of his "Practical Navigator," and making a few figures on his slate, to tell the spot which his vessel has reached on the trackless sea; and he can also tell it by means of a steel spring and a few brass wheels, put together in the shape of a chronometer. The glass with which he brings the heavens down to the earth, and by which he measures the twenty-one thousand six hundredth part of their circuit, is made of a quantity of flint, sand, and alkali—coarse opaque substances, which he has melted together into the beautiful medium, which excludes the air and the rain and admits the light,—by means of which he can count the orders of animated nature in a dew-drop, and measure the depth of the vallies in the moon. He has, running up and down his main mast, an iron chain, fabricated at home, by a wonderful succession of mechanical contrivances, out of a rock brought from deep caverns in the earth, and which has the power of conducting the lightning harmlessly down the sides of the vessel into the deep. He does not creep timidly along from headland to headland, nor guide his course along a narrow sea, by the north star; but he launches bravely on the pathless and bottomless deep, and carries about with him in a box a faithful little pilot, who watches when the eye of man droops with fatigue, a small and patient steersman, whom darkness does not blind, nor the storm drive from his post, and who points from the other side of the globe,—through the convex earth,—to the steady pole. If he falls in with a pirate he does not wait to repel him, hand to hand; but he puts into a mighty engine a handful of dark powder, into which he has condensed an immense quantity of elastic air, and which, when it is touched by a spark of fire, will instantly expand into its original volume, and drive an artificial thunderbolt before it, against the distant enemy. When he meets another similar vessel on the sea, homeward bound from a like excursion to his own, he makes a few black marks on a piece of paper and sends it home, a distance of ten thousand miles; and thereby speaks to his employer, to his family, and his friends, as distinctly and significantly as if they were seated by his side. At the cost of half the labor with which the savage procures himself the skin of a wild beast, to cover his nakedness, this child of civilized life has provided himself with the most substantial, curious, and convenient clothing, textures and tissues of wool, cotton, linen, and silk, the contri-

* *Osteology*, from the Greek words, signifying discourse on bone, being the demonstration of the forms and connection of the different bones.

butions of the four quarters of the globe, and of every kingdom of nature. To fill a vacant hour, or dispel a gathering cloud from his spirits, he has curious instruments of music, which speak another language of new and strange significance to his heart; which make his veins thrill, and his eyes overflow with tears, without the utterance of a word —and with one sweet succession of harmonious sounds, send his heart back, over the waste of waters, to the distant home, where his wife and his children sit around the fireside, trembling at the thought that the storm which beats upon the windows, may, perhaps overtake their beloved voyager on the distant seas. And in his cabin, he has a library of volumes—the strange production of a machine of almost magical powers—which, as he turns over their leaves, enable him to converse with the great and good of every clime and age, and which even repeat to him, in audible notes, the laws of his God, and the promise of his Saviour, and point out to him that happy land which he hopes to reach when his flag is struck, and his sails are furled, and the voyage of life is over.—[E. Everett.]

Rain Water.—In our country there falls rain, including melted snow, to the average depth of 35 inches. On a surface forty feet square, there falls yearly 34,909 wine gallons; and if all this were secured in cisterns, there would be nearly one hundred gallons for every day's consumption, or about three barrels. This water, if well preserved, would be the very purest and best for most domestic purposes. The horse and the cow prefer rain water to pump or well water; and though it would not be entirely governed by their decision, yet great respect is due to their judgment in such matters. The water of many wells is tinctured in such a way as to make it less fit for a solvent; and it does not so perfectly combine with nutritious substances, to form kyle, and nourish the human system. They who live in situations where water is not easily procured from the ground, may be told that the purest water is descending around them; and if they will only be at the necessary expense to secure this gift of heaven, they may provide an abundant supply. On such reservoirs the inhabitants of Palestine placed much dependence; and it is a merciful appointment of God, that in warm countries, where the greatest supply of water is needed, the most rain descends. We may yet find good capacious cisterns, of brick or stone, and Roman cement, economical additions to our domestic conveniences. A cistern ten feet square, and ten feet deep, would contain 118 hogsheads of 63 wine gallons each, and would secure to most families a constant supply of water.—[Scientific Tracts and Lyceums.]

Prize Medals to be awarded, for Discoveries in Science, by the Royal Society of London. [From the Journal of the Franklin Institute.]

Gentlemen,—I am directed by the American Philosophical Society to communicate to you, for publication, the annexed letter, received at their last stated meeting. The object of the Society is to diffuse the information given in that letter throughout the scientific community in the United States.

Very respectfully, yours,
A. D. Bache,
One of the Secretaries, Am. Philo. Soc.

Somerset House, Apartments of the Royal Society, London, Aug. 3, 1833.

Sir,—I am honored with the commands of His Royal Highness, the President of the Royal Society, to acquaint you, for the information of the American Philosophical Society, at Philadelphia, that His Majesty, the King, has been pleased to grant two gold medals of the value of £50 each, to be awarded by the Royal Society on the day of their anniversary meeting in each succeeding year, for the most important discoveries in any one principal branch of physical and mathematical knowledge.

His Majesty having graciously expressed a wish, that scientific men of all nations should be invited to afford the aid of their talents and researches, I am accordingly commanded by His Royal Highness the President to announce to you, sir, that the said Royal Medals for 1836 will be awarded in that year: the one for the most important unpublished paper on Astronomy, the other for the most important unpublished paper in Animal Physiology, which may have been communicated to the Royal Society for insertion in their Transactions, after the present date, and prior to the month of June, in the year 1836.

For the present, and the two following years, the Council of the Royal Society, with the approbation of His Majesty the King, have directed the Royal Medals to be awarded for important discoveries or series of investigations published within three years previous to the time of award; and those for the year 1833 have been adjudged, the one to Sir John F. W. Herschel, for his paper on the investigation of the Orbits of Revolving Double Stars, inserted in the fifth volume of the memoirs of the Royal Astronomical So-

ciety; the other to Professor Decandolle, for his investigations in Vegetable Physiology, as detailed in his work entitled Physiologie Vegetale.

I have the honor to be, Sir, your most obedient servant, CHARLES CUNIG,
For. Sec. Roy. Soc.

To the Secretary of the American Philos. Soc., Philadel.

DESCRIPTION OF THE VOCAL ORGANS.—[We are allowed to extract the following description of one of the most interesting parts of the human frame, from the Anatomical Class Book, by Dr. J. V. C. Smith,—the pioneer, we believe, of popular text-books on this subject.]

By voice, animals have the power of making themselves understood to their own species—and these sounds are either *articulate* or *inarticulate*.

Language is an acquired power, having its origin in the wants of more than one individual. Man, without society, would only utter a natural cry, which sound would express nothing but pain.

Supposing a human being to have been entirely forsaken by those of his species, in that state of infancy when he could have no recollection of any thing pertaining to his race, his voice would, in essence, remain the cry of an infant, only strengthened in tone, at a particular age, by the development of the vocal organs to their destined size.

But let two individuals be placed together, but without communication or knowledge of the existence of beings similar to themselves, the natural cry of each would undergo modifications: the one would make a sound, to express a particular sensation, which in time would be understood by the other: a repetition of the same note would be the sign of that sensation in future.

An additional sensation, having an intimate connection with the first, would require a variation of tone,—and this would also become a symbol of two sensations. Here then would be the origin of language. Multiply the species, and each new member of the society would express some other sensation or want, by another modification of the original cry. Here we discover the certain commencement of a spoken language; these different sounds becoming classified, constitute a dictionary, in which each word is the mark or sign of particular sounds; thus, if an individual can imitate the sound, or a series of sounds, he masters a language. Let it be remembered that man could never arrive to this perfection in sound or language, if his vocal organs were not differently constructed from brutes. Such is the mechanism of theirs, that so many sounds, and no more, can be made; but in man's organs, there is no limitation—no sound appreciable that he cannot imitate.

The Vocal Box, or Larynx.—Directly under the integuments on the front side of the neck, is a cartilaginous tube, the *trachea*, or wind-pipe, built up of a series of narrow strips, which are portions of a ring; therefore, it is always kept free and open. At its lower end it divides into two branches, going to the lungs on either side, but its upper portion is enlarged, just under the chin, and finally opens in common with the tube of the stomach and mouth. This enlarged part, quite prominent in man, is the *larynx* or vocal organ.

Several cartilages assist in its formation, viz., the *thyroid*, *cricoid*, the *arytænoid*, and the *epiglottis*. The cricoid is the foundation; the thyroid is the wall around it; the arytænoid are appendages to the back of the cricoid; and the epiglottis is a valve, opening and closing the entrance into the windpipe, like the valve of a bellows.

Fig. 1.

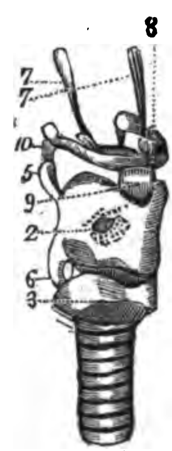
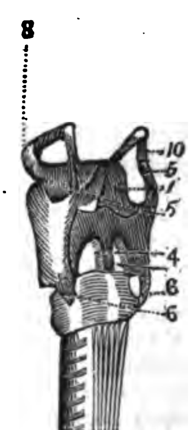


Fig. 2.



Explanation of figures 1, 2.—The five cartilages are—1, the epiglottis; 2, the thyroid cartilage; 3, the cricoid auxiliary; and 4, the two arytænoid cartilages; 5, the two superior horns of the thyroid cartilage; 6, the two inferior horns; 7, the suspensory ligament of the os hyoides; 8, the os hyoides; 9, the azygos ligament, connecting the os hyoides to the thyroid cartilage; 10, the two lateral ligaments connecting the horns of the os hyoides to the superior horns of the thyroid cartilage.

One of these diagrams presents a front and the other a back view of the *larynx* or vocal box. The bone of the tongue is seen,

like half of a hoop, marked 8, in both plans. 2 is the front of the *thyroid cartilage*, felt under the skin—protruding in the form of an irregular tumor. The wind-pipe is the tube at the bottom of each larynx. The *vocal cords*—the membranes which vibrate to produce sound, as the current of air rushes by—are concealed, being placed inside. From the remarks in the text, together with the references, a very correct idea will be formed of the structure of this curious organ. By blowing through the wind-pipe of almost any animal, soon after it is slain, provided the larynx has not been injured, the vocal cords may be put in motion, and the sound which is produced will bear considerable analogy to the natural voice of the animal.

Within the larynx, and consequently below the valve, are four delicate membranes, two on each side, put upon the stretch—being, in fact, like shelves—their thin edges nearly meeting from the opposite sides, so that there is scarcely any space between them. These are the vocal cords.

When the air rushes out from the lungs through the wind-pipe, it must obviously pass through the larynx,—in doing which it strikes the tense edges of the cords, and produces a vibration. This vibratory motion given to the current of air produces sound. In the cavities of the bones of the face, forehead and nose, its power is increased, and in the mouth it undergoes further modifications, and ultimately becomes articulate language. The teeth, tongue, lips, nose and fauces, have each an influence in the production of articulate sounds. Hence grammarians have arranged the human voice under the appropriate divisions of *guttural*, *nasal*, *dental* and *labial* sounds,—expressive of the agency which each of these organs exert on the original tone.

Shrillness or roughness of voice depends on the diameter of the larynx,—its elasticity, lubricity, and the force with which the expired air is propelled through the *rima glottidis*, or slit-like chink, between the vocal cords.

It is because the larynx is smaller in women, and more elastic, that their voice is of a different character. The breaking of the voice, (*vox rauca*,) noticeable in boys, at a peculiar age, depends partly on the enlargement of the apartments within the bones, which generally takes place at that important crisis of their lives, when the whole constitution undergoes a sudden change.

But the mechanism of voice would have been incomplete, were there not a number of exceedingly delicate muscles, which graduate the diameter of the narrow slit through which the sound escapes into the mouth. Unconsciously, they effect the requisite contractions, forever varying, according to the rapidity, intensity, or strength of the voice, in singing, conversation, or declamation.

Finally, the larynx is a musical wind instrument, of the *reeded* kind, on the principle of the hautboy. The nearness of the vocal cords to each other resembles the reed precisely. All the tones of reeded instruments are effected by finger holes,—but the tones of the human voice are varied by the extrinsic and intrinsic muscles, which shorten or elongate the vocal tube. Thus the same result is produced by this process,—increasing or diminishing the diameter of the larynx, that is accomplished in the clarionet, bassoon, flute and hautboy, by a graduated scale of finger holes.

Is not this another beautiful mechanical evidence of the existence of a Being superior to ourselves!

Lead in the United States.—The quantity of lead made at the U. S. Lead Mines during the year ending 30th September, 1833, was 7,941,792 lbs., of which goes to the United States, as rent, 472,645 lbs. Annexed is the statement of the quantity made at these mines since 1821:

From 1821 to Sept. 30,	1823,	535,130 lbs.
Year ending Sept. 30,	1824,	175,220 do.
" "	1825,	1,051,220 do.
" "	1826,	2,333,804 do.
" "	1827,	6,092,560 do.
" "	1828,	12,311,730 do.
" "	1829,	14,541,310 do.
" "	1830,	8,332,058 do.
" "	1831,	6,449,080 do.
" "	1832,	4,281,376 do.
" "	1833,	7,944,792 do.
Total,		63,845,740 lbs.

Novel Species of Street Pavement.—A gentleman lately from St. Petersburgh describes a new and ingenious mode of paving streets, successfully tried in that capital. Instead of wrought stones or Macadam's gravel (both of which are in use there) the Russians have employed blocks of wood, we presume hard wood, set on end. They are about a foot long, by eight or nine inches broad, and are cut into hexagons, which are closely joined and fitted to each other. When seen from a window in the second or third story, they present a regular and beautifully tesselated surface, like the inlaid oak floors seen in old houses. The droskies, which, from their heaviness and the smallness of their wheels, make an intolerable noise on the wrought stone pavement, pass over the blocks of wood as quietly as if they rolled on a carpet.—[Liverpool Albion.]

Statistics of the Globe.—The rapid population of the globe is estimated variously from 600,000,000 to 800,000,000; the geographical square miles at nearly 38,000,000, or 49,000,000 English square miles. The population to a square mile is, in France 61, Asia 27, Africa 10, America 3, Oceanica less than 1; the average of all about 17. The densest population in any whole province or state, is in Hamburg, where it is 1802 to a square mile. It is 980 in Bremen, 783 in Frankfort, 523 in Lubec, 464 in Lucca (Italy), 392 in Belgium, 314 in Saxony, 277 in Holland, 257 in Great Britain, the Sicilies 236, 208 in France, Austria 165, Prussia 155, Portugal 121, Denmark 119, Spain 101, Turkey 63, Greece 51, Russia 37.

In Asia some provinces have a population of from 200 to 500 to the square mile; Japan 139, China 42, Siam 57, English Indian Empire 185. In Africa, Morocco has 46, Tunis 45, and some of the interior kingdoms a little more. In America, Hayti has 36, Central America 12, Chili 10, United States 7½, Mexico 6.

The votaries of the different regions are reckoned as follows by Pinkerton:—Christianity 235,000,000, Judaism 5,000,000, Mahometan 120,000,000, Bramanism 60,000,000, Buddhism 180,000,000, all others 100,000,000.—[New-England Farmer.]

Stump Machine.—The last and best stump machine I have seen or heard of consists in a *wheel and axle*. A large but simple frame is supported by two upright posts within the frame, and upon the uprights an axle is made to revolve by a wooden wheel of some ten or twelve feet circumference, with a strong chain passing around its periphery. Two yoke of oxen will turn the wheel, and thus another chain, fastened to the axle and to the stump under the machine, is wound around the axle until the stump is torn from the earth. The machine, though light, is somewhat unwieldy; but the difficulty of transporting it from one stump to another might be removed by affixing wheels to it, and this would in no wise interfere with the operations of the machine. It is difficult to say how many stumps might be pulled in a day in this manner, for such computation would be influenced by a variety of circumstances, such as the character and size of the stumps, the nature of the soil, &c., but many hundred acres of the New-England territory have been cleared by this machine, at the rate of $10 the acre; and in some instances large tracts of land, which were once thickly wooded, have been rendered stumpless for the small sum of eight dollars the acre, every stump, exceeding six inches in diameter, being removed. —[North. Courier.]

Economy in the Use of Steam. [Communicated for the American Railroad Journal, and Advocate of Internal Improvements.]

It has been for several years past, to the writer, an important object, and a favorite study, to effect, if possible, a saving in the use of steam; and after a great variety of experiments on the subject, he has arrived at the conclusion, and believes he can demonstrate clearly to every rational mind, by actual experiment, a saving of nearly one-half, by the use of double cylinder engines. In order to illustrate the fact, he has fitted up a small model, so arranged as to give every possible chance to test fairly the correctness of his theory. The machine above mentioned is constantly in operation at Wm. T. James' foundry and steam engine factory, No. 40 Eldridge street, where those interested in such matters are respectfully invited to call and satisfy themselves.

Specification of a Patent for a New Manufacture of Wheels for Locomotive Engines and Cars, to run upon Railroads, granted to Matthias W. Baldwin, *city of Philadelphia, June* 29, 1833. [From the Journal of the Franklin Institute.]

To all whom it may concern, be it known, that I, Matthias W. Baldwin, of the city of Philadelphia, have invented a new and useful manufacture of wheels for locomotive engines and cars, to run upon railroads, and that the following is a full and exact description of my said invention.

Instead of making the wheels for the carriages of locomotive engines, and of other cars, or carriages, to be used upon railroads, of cast iron, or of a combination of cast and wrought iron, or of wood combined with cast or wrought iron, or with both, as they have been heretofore made, I cast the rims of such wheels, as well as in most instances the spokes and hubs, or naves, in one piece with the rims, of a composition of metal known to workmen under the name of hardened brass, or gun metal. It is not necessary for me to designate the proportions in which the respective metals are mixed which form the hardened brass or gun metal, as these will vary with the degree of hardness desired in the rim, or tread, of the wheel, in a manner well known to those conversant with the casting of brass and its compounds. Where it is desirable to increase the adhesion between the rail and the wheel, it may be found necessary to make the wheel proportionably softer, by decreasing the quantity of tin entering into the composition of them, or even to cast them of soft brass or of copper entirely.

I do not intend to confine myself to any particular form for the tread of the wheel, or for the spokes and hub; but to modify it in such way as experience may suggest to be the best adapted to the particular carriage or road to which the wheel is to be applied. I intend sometimes also, to cast the rim of the wheel of such metal without spokes, but furnished with such flanches, lodgments, or projections, as shall enable me to attach thereto, spokes of wood, iron, or other material.

My claim to an exclusive privilege I rest entirely upon a new manufacture of such wheels, by substituting for their rims, or for every part of them, a new material as hereinbefore set forth, the utility of which consists in its being better adapted to the purposes which they are intended to answer in running upon railroads.

Matthias W. Baldwin.

On Saxton's Improved Method of Propelling Carriages. By A Reader. To the Editor of the Mechanics' Magazine, and Register of Inventions and Improvements.

In your Magazine, Vol. II, page 251, you furnished your readers with the specification of a patent obtained in England by Joseph Saxton, for an improved method of propelling carriages. On reading it, I was very much pleased with the result promised, and at the same time rather incredulous, doubting whether the inventor had not deceived himself. I could not see through the principle, but did not think that any argument against the truth. I find I was not singular, for it is stated that "Many able engineers had found a difficulty in comprehending the principle." So, thinking it highly curious, and to put an end to my doubts, I made a small model. It works to admiration, and is the delight of every one who has seen it. It is a beautiful mechanical toy, but I am persuaded can never be used advantageously on so great a scale as railroad transportation would require. I had no intention of troubling you—it is the first time I have done so; but the subject has acquired new interest in my view, by the announcement, in a London paper, of some steps taken towards introducing the principle into practice.

I send inclosed the communication referred to, and I am, sir, A Reader.

New-York, 3d Feb., 1834.

Experimental Railway.—A lecture was given, or rather a conversation was held, yesterday noon, at a temporary building and railway, situate in Park street, near the Gloucester gate, Regent's Park, on the "Economical, rapid, and safe travelling upon railways by means of Mr. Saxton's patent locomotive differential pulley; by which simple invention (the placard states) a horse, walking at the rate of two or three miles an hour, will be able to propel a carriage at the rate of thirty miles an hour."

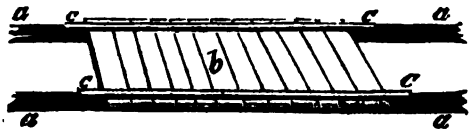
It appears that a few civil engineers and gentlemen being desirous of trying this invention, a piece of ground is formed into a railway of a quarter of a mile in extent, for the purpose of trying experiments, and yesterday the introductory lecture was given, and several models exhibited.

A Mr. Hawkins, who officiated, addressed the few gentlemen present, by observing that the railway was not in a sufficient state to try any experiments then, and he hoped no gentleman had come there under that impression; if so, his money should be returned. What he contemplated on the present occasion was to explain the principles on which Mr. Saxton's invention was founded, and to elucidate the same by models. This invention was calculated to propel a carriage at the rate of one mile in two minutes; the railway before them when completed would be a quarter of a mile in length, which distance and back, being half a mile, he anticipated performing in one minute. Ultimately he considered the distance from London to York might be performed in about six hours, and he did not despair of achieving in the same way a journey from the metropolis to Edinburgh in the space of one open day. The present invention was a new application of leverage, and one which was rather difficult to be understood, unless put in operation. Many able engineers had found a difficulty in comprehending the principle; but he would use his best endeavors to make himself clearly understood, and should feel happy in answering any question put to him. It consisted of having ropes, one mile in length, extending along the railway, and by means of Mr. Saxton's differential pulley, it was calculated that, with the power of one horse, a carriage, containing passengers to the weight of about one ton, could be propelled at the rate already stated of thirty miles an hour. It would require one horse to each mile, but whilst the carriage proceeded at the rate of thirty miles, the horse would only perform a distance of 150 yards; at the end of each mile fresh ropes were applied to the carriage, a fresh horse worked the second pulley, and thus it proceeded on the journey, a person being stationed at the end of each mile to effect the change of geerage. By these means, it was asserted, the greatest acclivity might be ascended, and the experimental railway would be so formed as to show its effect in this particular, part of it being on the same scale of declivity as Shooter's Hill, or one foot in ten. He next proceeded to show, by means of diagrams and models, the mode in which the propelling force was acquired by the newly invented pulley, and then proceeded to state that it was not his intention to run heavy carriages on the railway. One ton, he thought, would be quite sufficient, because, when they could send ton after ton at the rate of thirty miles an hour, and without any delay between, carrying great weights was unnecessary. On the present plan of locomotive engines, it was indispensible that they should be formed to carry heavy weights, because the locomotive engine generally weighed ten tons; and that great weight, being in a state of agitation, wore out and damaged the road infinitely more than all the traffic that passed over. It was found also that one locomotive engine required three times as much fuel as a stationary engine of the same power. It was his intention to use horses, because one-horse power would be sufficient for his purpose; and it was found that there was no saving in using engines under six-horse power, it being as cheap to keep six horses as to work a six-horse engine. There would, in this way, be a great saving in the expense of the power; there would also be a great saving in the construction of the railway. At present a yard of railway weighs 50 lbs.; his would weigh less than half. At present hills are cut down, and valleys raised, to make a railway; by the proposed plan this would be unnecessary.

Mr. Hawkins, having concluded his lecture, answered several inquiries made of him by gentlemen present, and received their best wishes for his success. In the course of the conversation, he mentioned that the manufacturer who had made the rails for the company was now executing an order from America for 1,000 miles of railway.

A New Plan for the Construction of the Wood Work of Railroads. By Elisha Johnson. To the Editor of the American Railroad Journal, and Advocate of Internal Improvements.

Sir,—Having introduced a new plan for the construction of the wood work of railroads, which is adopted by the directors of the Buffalo and Black Rock Railroad Company, I wish, through your valuable Journal, to give a brief description of the same, in answer to inquiries that have been made.



Place longitudinal sills, *a a*, of round timber one foot in diameter, hewed on one side, even with the surface of the grade; cover the road bed with plank, *b*, two and one-half inches in thickness, and seven feet long, resting upon the grade and sills; over the sills place two by four inch scantling, *c c*, on which are placed the iron plates: all of which parts are secured by eight-inch spikes, terminating in the sills.

The plan is proposed for new districts of country, where the location of the line of road is through low table lands, or the rich farming lands of secondary formation, which are retentive of moisture, or light sand soils; all of which would require expensive preparations of the grade by rubble or gravel blind drains, &c., to prepare for the reception of the timber work.

In the usual form of timber constructions, it has a superficial bearing of twenty-nine feet upon the grade, to the rod. In the above form, there is one hundred fifteen and one-half feet of bearing per rod, increasing the strength of road in proportion to its bearing, on unprepared grades, and ample strength for locomotive power with heavy trains, on alluvial soils.

The expense of materials is about the same in either plan, where suitable timber for rails can be obtained in the vicinity of the line of road.

The improvement proposed consists in saving the expense of a prepared grade and horse path, varying in cost from one to two thousand dollars per mile; also, a saving of the item of suitable rails, when they have to be obtained at great expense of transportation, as well as the mechanical work connected with them.

The plan proposes other advantages, viz.: the admission of the use of such timber as is most convenient to obtain near the line of road; a material saving of expense in passing water-courses, bridges; and the construction of turnouts and crossings by a continuous floor, which forms a roof to the grade; when by use and the effect of rains, the joints of the timber are filled with earth, the water passing off through triangular apertures △, at the meeting at the ends of the supports to the iron; greater security from the effect of frost, by reason of the form of construction and a dry grade; the spike that secures the iron, secures the different parts of the timber work; a dry horse-path, which is proposed to be protected by the use of a thin coating of sand over the floor—this will protect the timber from the effects of the sun, and preserve a more uniform moisture, aiding the preservation of the timber.

In reference to objections that may be urged against proposed improvements, it is not practicable to answer them fully, except by the test of experiment. In the construction and use of such a form of road, it is suggested that it may be inconvenient to repair an imperfect embankment, which is remedied by the ease which the wood work may be taken up and put down again, or by having movable plank at every three or five feet, to be drawn out from between the spike or every other plank moveable, if screwed six inches in width.

The wear of the plank and the effect upon the horse at a speed of ten miles per hour, are proper questions of inquiry. In answer, the wear of the plank: by comparisons made without protection, as proposed, it is satisfactorily ascertained that the wear will be less than the decay for the amount of horse power required on railroads, if locomotive power is not used. The effect upon the horse is believed to be more favorable than upon a compact gravel road in dry weather or frozen earth, ice, or stony roads, if not relieved by the sand covering.

A question may arise, of comparative effect upon the decay of the timber. In the common form, parts of the work, such as the tenants of the cross timber or sleepers, are believed to be in the most exposed situation they can be placed; when in the proposed form, by a continuous bearing upon the grade, the timber can be used in an advanced state of decay.

The simple form of construction removes a prominent cause of expense in the details of the management of laborers and mechanics necessary in completing the several parts in the common form of construction: if connected with the contracts for grading, the sills are put into the grade as a part of the contract. Twelve days, with one superintendant, one mechanic, and six laborers, will complete a mile of road, with the materials delivered on the line, tested by experiments that have been made; the time required is the time necessary to drive the spike.

In adopting the aforesaid principle of transferring the strength of rail to the sill, and obtaining strength of grade by increasing the superficial feet of bearing, will admit of many variations from the above described form, in the

size, quality, and quantity of timber, in different descriptions of grade, and in the use of red cedar, with many other particulars not proposed to be entered upon in this communication.

The experiment that has been made in the completion of three-fourths of a mile on the Buffalo road, have been favorable in the results; and in the experiments of loaded cars on the track, a favorable effect was noticed by reason of the continued bearing and direct connection with the grade, particularly on a part of the grade that was loose clean sand, which, from its confined position, had the apparent effect of a stone foundation: the grade receiving all of the action of a moving heavy body.

If these remarks should contribute to useful inquiry, and an improvement made in the form of construction, adapted to the age and circumstances of our country, where capital bears a high rate of interest, and the present limited business of different sections not warranting expensive constructions, would be all that could be expected from these imperfect remarks.

ELISHA JOHNSON, Civil Engineer.

Rochester, Jan. 24, 1834.

COAL STEAM BOILERS.—The construction of steam boilers of such a form as to admit of the use of anthracite coal for fuel, instead of wood, has long been a desideratum. In the engine and apparatus of the steamboat Novelty, it was first designed to use coal, but from some imperfection or obstacle then yet unsurmounted, in the arrangement and adaptation of the furnace and boilers, that design was abandoned.

It is now understood that Dr. Nott has persevered in his experiments for the construction of a boiler and furnace, in which coal may be used to greater advantage than wood, till success has crowned his efforts. But what the form or fashion of his contrivance is for this purpose, we are not informed.

We see it stated in a New-York paper, that a Mr. Disbrow, already favorably known to the public as an ingenious and enterprising mechanic, has likewise succeeded in constructing a "*Lackawana coal boiler*," one of which is in operation on board the steamboat Delaware, and of which an individual who witnessed its operation says, "it accomplishes all the anticipations of the inventor."

CRUCIBLE FOR FUSION.—Make a hole in a Hessian crucible, holding two or three quarts; put inside of this crucible the cover of a smaller crucible, so that it may rest about three-fourths of the depth; make with a file several notches around this cover to admit the air fairly, having the knob of the cover uppermost. On this knob place a little crucible containing the metal, which must be covered; put some lighted charcoal around it, and then fill up with coke, so as to cover entirely the interior crucible. Connect this apparatus with a blacksmith's or other bellows, and keep up a constant blast, supplying the waste coke as it is consumed; in the course of 20 minutes the steel will be melted. Other minerals, even some that are reputed infusible, will yield in like manner. This simple and cheap apparatus abridges time and labor surprisingly, and effects what, with the common and costly furnaces, would be impossible.—[Jour. de. Con. Usuelles, tom. xv. p. 143.]

TIMBER, by the process of charring or burning the surface, may be preserved for an indefinite time, even though exposed to damp, or buried in the earth. The utility of charring timber used for posts or water works, is so evident, that we are surprised it is not more generally attended to. The most wonderful proof of the indestructibility of charcoal timber is given in Watson's Chemical Essays, where we are informed "that the beams of the theatre of Herculaneum were covered with charcoal, by the burning lava which overflowed that city; and during the lapse of 1,900 years, they have remained as entire as if they had been formed but yesterday." This property was well known to the ancients, as the famous temple of Ephesus was built on piles charred to preserve them from decay; and some years ago, piles were found in the Thames, charred, in a perfect state of preservation, in the very spot where Tacitus relates that the Britons drove in piles to prevent the attack of the fleet of Julius Cæsar.

SALT SPRINGS.—*Supply of Water in the Onondaga Salt Springs.*—The actual consumption of water annually cannot be less than 90 or 100,000,000 gallons, averaging 260,000 gallons per day, for 365 days, though the consumption during the summer months cannot be less than 7 or 800,000 gallons per day.—[Onondaga Standard.]

FOR DIPPING BLACK SILKS, WHEN THEY APPEAR RUSTY OR FADED.—Your discretion must be used whether the silk can be roused, or whether it requires to be re-dyed. Should it require re-dying, this is done as follows: for a gown, boil two ounces of log-wood; when boiled half an hour, put in your silk, and simmer it half an hour, then take it out and add a piece of blue vitriol as big as a pea, and a piece of green copperas as big as the half of a horse bean; when these are dissolved, cool down the copper with cool water, and put in your silk, and simmer half an hour, handling it over with a stick; wash and dry in the air, and finish as above. If only wanting to be roused, pass it through spring water, in which is half a tea spoonful of oil of vitriol. Handle in this five minutes, then rinse in cold water and finish as above.

FOR DYING GREEN.—Take blue and oil of vitriol, mix them together; then take fustic, boil it till it is a good color, then put in your vitriol until it is the shade of green you want; wet your silk all over with warm water first, put your dye on, and hang it in the sun, then brush it off as before.

The Unbeliever.—I pity the unbeliever—one who can gaze upon the grandeur, and glory, and beauty, of the natural universe, and behold not the touches of His finger, who is over, and with, and above all; from my very heart I do commiserate his condition.

The unbeliever! one whose intellect the light of revelation never penetrated; who can gaze upon the sun, and moon, and stars, and upon the unfading and imperishable sky, spread out so magnificently above him, and say all this is the work of chance. The heart of such a being is a drear and cheerless void. In him, mind—the god-like gift of intellect, is debased, destroyed; all is dark—a fearful chaotic labyrinth—rayless—cheerless—hopeless!

No gleam of light from heaven penetrates the blackness of the horrible delusion; no voice from the Eternal bids the desponding heart rejoice. No fancied tones from the harps of seraphim arouse the dull spirit from its lethargy, or allay the consuming fever of the brain. The wreck of mind is utterly remediless; reason is prostrate; and passion, prejudice, and superstition, have reared their temple on the ruins of his intellect.

I pity the unbeliever. What to him is the revelation from on high, but a sealed book? He sees nothing above, or around, or beneath him, that evinces the existence of a God; and he denies—yea, while standing on the footstool of Omnipotence, and gazing upon the dazzling throne of Jehovah, he shuts his intellect to the light of reason, and denies there is a God.—[Chalmers.]

The Chasseur Ants of Trinidad.—One morning my attention was arrested at Laurel Hill by an unusual number of black birds, whose appearance was foreign to me; they were smaller but not unlike an English crow, and were perched on a calibash tree near the kitchen. I asked the house negress, who at that moment came up from the garden, what could be the cause of the appearance of those black birds? She said, "Misses, dem a sign of the blessing of God; dey are not the blessing, but only de sign, as we say, of God's blessing. Misses, you will see afore noon-time how the ants will come and clear the houses." At this moment I was called to breakfast, and thinking it was some superstitious idea of hers, I paid no further attention to it.

In about two hours after this, I observed an uncommon number of *chasseur ants* crawling about the floor of the room: my children were annoyed by them, and seated themselves on a table, where their legs did not communicate with the floor. The ants did not crawl upon my person, but I was now surrounded by them. Shortly after this the walls of the room became covered by them; and next they began to take possession of the tables and chairs. I now thought it necessary to take refuge in an adjoining room, separated only by a few ascending steps from the one we occupied, and this was not accomplished without great care and generalship, for had we trodden upon one, we should have been summarily punished. There were several ants on the steps of the stair, but they were not nearly so numerous as in the room we had left; but the upper room presented a singular spectacle, for not only were the floor and the walls covered like the other room, but the roof was covered also.

The open rafters of a West India house at all times afford shelter to a numerous tribe of insects, more particularly the cockroach, but now their destruction was inevitable. The chasseur ants, as if trained for battle, ascended in regular thick files, to the rafters, and threw down the cockroaches to their comrades on the floor, who as regularly marched off with the dead bodies of cockroaches, dragging them away by their united efforts with amazing rapidity. Either the cockroaches were stung to death on the rafters, or else the fall killed them. The ants never stopped to devour their prey, but conveyed it to their storehouses.

The windward windows of the room were of glass, and a battle now ensued between the ants and the *jack-spaniards* on the panes of glass. The jack-spaniards may be called the wasp of the West Indies; it is twice as large as the British wasp, and its sting is in proportion more painful. It builds its nest in trees and old houses, and sometimes in the rafters of a room. These jack-spaniards were not quite such easy prey as the cockroaches had been, for they used their wings, which not one cockroach had attempted to do. Two jack-spaniards, hotly pursued on the window, alighted on the dress of one of my children. I entreated her to sit still, and remain quiet. In an inconceivably short space of time, a party of ants crawled upon her frock, surrounded and covered the two jack-spaniards, and crawled down again to the floor, dragging off their prey, and doing the child no harm. From this room we went to the adjoining bedchamber and dressing-room, and found them equally in possession of the chasseurs. I opened a large military chest full of linens, which had been much infested; for I was determined to take every advantage of such able hunters. I found the ants already in possession of the inside; I suppose they must have got in at some opening at the hinges. I pulled out the linens on the floor, and with them hundreds of cockroaches, not one of which escaped.

We now left the house and went to the chambers built at a little distance, but these were also in the same state. I next proceeded to open a store-room at the end of the other house for a place of retreat, but to get the key I had to return to the under room, where the battle was now more hot than ever. The ants had commenced an attack on the *rats* and *mice*, which, strange as it may appear, were no match for their apparently insignificant foes. They surrounded them as they had the insect tribe, covered them over, and dragged them off with a celerity and union of strength that no one who has not watched such a scene can comprehend. I did not see one rat or mouse escape; and I am sure I saw a score carried off during a very short period. We next tried the kitchen, for the store-room and boys' pantry

were already occupied, but the kitchen was equally the scene of battle between rats, mice, and cockroaches, and ants killing them. A huckster negro came up selling cakes, and seeing the uproar, and the family and servants standing out in the sun, he said, "Oh, Misses, you've got the blessing of God to-day, and a great blessing it is to get such a cleaning."

I think it was about ten when I first observed the ants; about twelve the battle was formidable; soon after one the great strife began between the rats and the mice; and in about three the houses were cleared. In a quarter of an hour more the ants began to decamp, and soon not one was to be seen within doors. But the grass around the house was full of them; and they seemed now feeding on the remnants of their prey, which had been left on the road to their nests; and so the feasting continued till about four o'clock, when the black birds, who had never been long absent from the *calibash* and *pois doux* trees in the neighborhood, darted down among them, and destroyed by millions those who were too sluggish to make good their retreat. By five o'clock the whole was over: before sundown, the negro houses were all cleared in the same way; and they told me that they had seen the black birds hovering about the almond trees close to the negro houses as early as seven in the morning. I never saw the black birds before or since, and the negroes assured me that they were never seen but at such times.—[Mrs. Carmichael on the West Indies.]

Compression of Water.—Mr. Jacob Perkins has invented an apparatus, which, by hydrostatic pressure, compresses water to an extent equal to a fourteenth part of its volume. The force employed is equivalent to a pressure of 30,000 lbs. to the square inch, and is applicable to other fluids. In most of our works on natural philosophy, water is treated as incompressible and non-elastic; by this apparatus the opposite of these two propositions is clearly shown. There was a considerable difficulty in getting a vessel capable of resisting so high a pressure; and the chief feature of this instrument is the manner of constructing the cylinder, which is formed of a series of concentric tubes: thus the inner or smaller tube is first formed by welding, and is turned accurately on the outer surface; the next tube is then formed, and is accurately turned on the inner surface, and the bore of this second or outer tube is just too small to receive the first tube, but, in order that it may do so, it is heated, till, by expansion, it is capable of receiving the first tube within it, and in cooling, the second tube shrinks on the first tube and strongly embraces them together; a third tube, a fourth, and so on, are similarly put on, till a cylinder is produced capable of withstanding any pressure.—[Repertory of Patent Inventions.]

Popular Errors in Medicine—[By an Edinburgh Physician.]—A very common practice in eating such fruit as cherries is to swallow the stones, with the vague notion that these promote digestion. No error can be more fatally absurd. Many cases have occurred where such practices have been the cause of death, and that of a very excruciating nature. One instance is on record of a lady who died in great agony after years of suffering, and the cause was found to be several large balls lodged in the intestines, accumulated around clusters of cherry stones. The husks of gooseberries are often swallowed with the idea that they prevent any bad effects from the fruit. On the contrary, they are the most indigestible substance that can be swallowed, and pass the stomach without any change, although they cause excessive irritation, and not unfrequently inflammation in the bowels.

Many people put great faith in the wholesomeness of eating only of one dish at dinner. They suppose that the mixture of substances prevents easy digestion. They would not eat fish and flesh, fowl and beef, animal food and vegetable. This seems a plausible notion, but daily practice shows its utter absurdity. What dinner sits easier on the stomach than a slice of roast or boiled mutton, and carrots or turnips, and the indispensable potato? What man ever felt the worse of a cut of cod or turbot followed by a beef-steak, or a slice of roast beef and pudding? In short, a variety of wholesome food does not seem incompatible at meals, *if one do not eat too much*—here the error lies.

It is a practice with bathers, after having walked on a hot day to the sea-side, to sit on the cold rocks till they cool before going into the water. This is quite erroneous. Never go into the water if over-fatigued, and after profuse and long-continued perspiration, but always prefer plunging in while warm, strong and vigorous, and even with the first drops of perspiration on your brow. There is no fear of sudden transitions from heat to cold being fatal. Many nations run from the hot bath and plunge naked into the snow. What is to be feared is sudden cold after exhaustion of the body, and while the animal powers are not sufficient to produce a reaction or recovery of the animal heat.

There is a favorite fancy of rendering infants and farther advanced children hardy and strong by plunging them into cold water. This will certainly not prevent strong infants from growing stronger, but it will, and often does, kill three children out of every five. Infants always thrive best with moderate warmth and a milk-warm bath. The same rule applies to the clothing of infants and children. No child should have so slight clothing as to make it feel the effects of cold—warm materials, loose and wide-made clothing, and exercise, are all indispensable for the health of little ones. But above all things, their heads should be kept cool, and generally uncovered.

Many people so laud early rising as would lead one to suppose that sleep was one of those lazy, sluggish, and bad practices, that the sooner the custom was abolished the better. Sleep is as necessary to man as food, and as some do with one-third of the food that others absolutely require, so five hours' sleep is amply sufficient

for one, while another requires seven or eight hours. Some men cannot by any possibility sleep more than four or five hours in the twenty-four; and, therefore, true to the inherent selfishness of human nature, they abuse all who sleep longer. No man should be taunted for sleeping eight hours if he can.

Many people do not eat salt with their food, and the fair sex have a notion that this substance darkens the complexion. Salt seems essential for the health of every human being, more especially in moist climates such as ours. Without salt, the body becomes infected with intestinal worms. The case of a lady is mentioned in a medical journal, who had a natural antipathy to salt, and never used it with her food; the consequence was, she became dreadfully infected with these animals. A punishment existed in Holland, by which criminals were denied the use of salt; the same consequence followed with these wretched beings. We rather think a prejudice exists with some, of giving little or no salt to children. No practice can be more ridiculous.

Indian Mode of Education.—Whatever the child learns, he learns for the most part from observation of his elders and his comrades. He soon finds *pride* is the spur of his exertions. He soon finds that success as a hunter will make him respected by his tribe, while awkwardness subjects him to intolerable ridicule. He listens to every thing that is said of hunting and trapping at home, and eagerly goes abroad with the view of earning some praise for himself. Thus it takes him but a few years to acquire a considerable degree of experience; and his reputation always corresponds to his merit. The same feeling just mentioned is appealed to with equal success in regard to most other branches of an Indian education. It is true, to a great extent, of numerous tribes, as Heckewelder observes respecting the Delawares, that a father need only to say in the presence of his children, 'I want such a thing done; I want one of my children to go upon such an errand; let me see who is the *good* child that will do it?" This word *good* operates, as it were, by magic, and the children immediately vie with each other to comply with the wishes of their parent. If a father sees an old decrepit man or woman pass by, led along by a child, he will draw the attention of his own children to the object, by saying, 'What a *good* child that must be, which pays such attention to the aged! That child, indeed, looks forward to the time when he himself will be old!' or he will say, 'May the great spirit, who looks upon him, grant this *good* child a long life!' In this manner of bringing up children, the parents, says Heckewelder, are seconded by the whole community. If a child is sent from his father's dwelling to carry a dish of victuals to an aged person, all in the house will join in calling him a *good* child. They will ask whose child he is, and, on being told, will exclaim, 'What! has the *Tortoise* or the *Little Bear* (as the father's name may be) so excellent a child?' If a child is seen passing through the streets, leading an old decrepit person, the villagers will, in his hearing, and to encourage all other children who may be present to take example from him, call on one another to look and see what a *good* child that must be. And so, in most instances, this method is resorted to for the purpose of instructing children in things that are good, proper, or honorable in themselves; while, on the other hand, when a child has committed a *bad* act, the parent will say to him, 'Oh! how grieved I am that my child has done this *bad* act! I hope he will never do so again.' This is generally effectual, particularly if said in the presence of others. The whole of the Indian plan of education tends to elevate rather than depress the mind, and by that means to make determined hunters and fearless warriors.—[Indian Traits.]

The Jackson Cotton Gin.—Mr. James Lynch, an ingenious mechanic of this place, has invented a new kind of Cotton Gin, to which he has given the above title. We should suppose from the name that it was intended to operate with a *powerful impulse*.

We have seen a model of the gin; but owing to the fact that we are not much acquainted with machinery of the kind, we are unable to speak with certainty of its advantages. It differs from the common gin in these respects: it contains three separate sets of cylindrical pickers, which are shorter and smaller than the common saw cylinder —and the teeth are finer. The arrangement of these pickers is one above another, the largest set being below, and presenting a front a little convex. The breast or ribs are of a peculiar form, not easily described, and wrought or cast of one piece of sheet metal. The seed cotton rolls in the hopper as in other gins, and is taken from all the pickers and thrown out at the flue, by one cylindrical brush. All the cylinders turn upon points, and are driven by two belts, passing over a drum in the rear of the machine.

The advantages of this gin are supposed to consist in its despatch; its requiring less power; occupying less space; being less apt to cut or injure the staple; picking cleaner; being less liable to take fire from friction; and from its being less liable to

choke and get out of repair, than those now in use.

Mr. Lynch intends going to Pittsburg shortly, with a view of procuring castings for this and other machinery. We wish him much success in the laudable enterprize.

Jenning's Patent and Premium Combined House Warmer and Cooking Apparatus. [Communicated by the Inventor.]

REFERENCES.—1 1, Hot air registers. 2 2, Taps for the admission of cold water to supply the boilers, and for other purposes. 3 3, Tubes for conveying the steam from the side boilers, 6 6, into the hot air chambers, to restore as much moisture to the rarified air as the heated furnace may have deprived it of. 4, Hot closet. 5, An aperture to allow the surplus steam of the boilers to escape into the smoke flue. 6 6, Two side boilers providing a large and constant supply of hot water for family use. 7, Bake oven, always hot. 8, Furnace inclosed in brick work. 9, Ash pit. 10 10, Taps to draw off hot water from the side boilers. 11, Fire Register.

N. B.—The sash lights are used when the apparatus is not set in a recess to confine the steam, smell, &c. of the cooking, which pass off into the smoke flue.

This highly approved invention, for health, economy, and comfort, is allowed to be superior to any thing hitherto known, being adapted for, and capable of application to, every description of private as well as public buildings, (old or new,) so that with but one fire of anthracite coal, at less expense and labor than a usual kitchen fire, it will effect every thing required for cooking and laundry purposes, and also warm every apartment in the house to any agreeable temperature, with pure atmospheric air.

The fire not being allowed to go out during the winter season, an even, agreeable temperature is constantly kept up in the rooms, halls, passages, &c. It being entirely free from smoke, dust, gas, &c. one half of the usual domestic labor is saved. Cost, from 60 to $150.

This apparatus may be made to possess also the advantages of cooling the air of the apartments in summer, to about an arithmetical mean between the temperature of the air and the earth, by means of an extended cold air flue. The whole apparatus may be removed from one building to another at a trifling expense.

We have much pleasure in inserting the following testimonials of its worth:

"So important an improvement do we consider this method of warming apartments, that we trust the time is not far distant when no building of any size will be erected without the necessary means for putting it into execution.

"Rumford declares that, notwithstanding his first prejudices against stove heat, he found, from an experience of twelve years' residence in Germany, not only that warm rooms were more comfortable in winter, but also certainly tended to the preservation of health."—[Journal of Health.]

"Talk of the comforts of an English fire, indeed! There is not a nation upon earth, between this latitude and the pole, but knows more of the comforts of a fire than England does. The party seeking is placed at the wrong end of the apparatus, like that of a person obtaining flour or meal, who should expect to receive it at the hopper, before it has passed the millstones: he is situated at the source of supply, and not of the produce; the raw material is rushing from him, instead of his receiving that which has undergone the beneficial process."—[Gray's Operative Chemist.]

We, the undersigned, having used Joseph Jennings' Cooking Apparatus, combined with a Hot Air Furnace, in our dwelling houses, during the whole of the past winter, do cer-

tify, that we consider it the most economical, healthy, agreeable, and convenient method ever invented.

Thomas Stokes, 53 Sixth street.
Geo. L. Spencer, 38 do.
John Brown, 40 do.
B. Palmer, 145 Reed street.

To Mr. Jennings, 42 Sixth street:

I have used your Cooking Furnace and Hot Air Apparatus for five months. I think, for health, comfort, cleanliness, and economy, there is nothing like it in this country, or any other. Abm. T. Hunter, M. D.
17 Hudson street.
New-York, Feb. 22, 1832.

I have had one of your furnaces in use for the last winter, and am very much pleased with it; I have seen nearly all of the different patterns of furnaces used in the city, and I am sure that there is none to equal it for heat and economy. H. W. Titus,
Builder, 113 Greenwich street.
New-York, September 6, 1832.

During the winter we have fearlessly kept up as hot a fire during the night as by day; and I can see no possible danger from fire when the apparatus is constructed upon your plan. As regards its influence upon health, our experience thus far proves it decidedly beneficial. Respectfully, yours,
Hudson Kinsley, M. D.
New-York, April 18, 1833.

A Proposal.—American children, by contributing one cent a week each, for ten years, might procure two hundred millions of testaments .If each of these were read by four persons, every member of the human family might hear of the *glorious freedom* of the gospel. And would not such a blessing, conferred upon the world by the children of our nation, be a blessing to them? Is such a blessing for our nation and the world impracticable? Is there one of the four millions of American children who cannot procure one cent to give on every Monday morning for some object of *Christian benevolence*? Is there one parent in the nation who would refuse to a child the blessing of giving? Where then is the difficulty? Why not commence at once upon a measure so easy; upon an object so great, and christian, and glorious? Why would it not be wise for each of the 50,000 teachers in the nation to propose to their pupils to contribute on next Monday morning one cent each for some object of common benefit to their school, or of good to another school, or another State, or nation, or continent? Since the practice of *systematic benevolence* for schools and families is so simple, so easy, so great, and so christian, who is not ready to begin?

MANKIND MUTUALLY DEPENDANT.

Not only the correct and excellent sentiments, and the accom plished expression of the following communication, but the source from which it emanated, give it a value for our p per. It is one among numerous compositions furnished by the Ladies' Composition Class of the Boston Wesleyan Lyceum. This piece, like many others which have been prepared by this class, does credit to the intellect and still more to the heart of the author The sentiment and spirit manifested are those of christian kindness; and if believed and practised by the whole human family, would light up our depraved and forlorn world with the brightness of pure felicity Who is not ready to try the experiment?

The cold-hearted stoic may boastingly accede to the sentiment, that 'man is sufficient for himself;' but the philanthropist rejoices in the beautiful systèm of mutual dependance which unites him so closely with the whole human family. He views with pleasure the facilities which the genius of men has supplied for communication with other lands; for contributing to the necessities, convenience and ease of each other, by exchanging the products of different climes; he considers all men as the children of one Parent, improving the advantages with which they are favored, for the benefit of themselves and of their brethren.

Not only do these pleasurable feelings arise in the breast of him whose heart is deeply imbued with love for the whole human race, but a little reflection will excite them in the mind of one whose views are more selfish and contracted; and constrain him to acknowledge the wisdom of a system for the division of labor, and for the promotion of friendly intercourse, which mankind, as it were by mutual consent, have so universally adopted.

Every vocation in life depends on many others for its support. The agriculturists of New-England, said to be the most independent class of people, may be adduced as examples in favor of this assertion; the toils of the blacksmith, the carpenter, &c. are all put in requisition to enable them to cultivate the soil to advantage.

The rich are dependant on the poorer classes, and the poorer classes on the wealthy: without the former, commerce and manufactures would languish—and deprived of the latter, the fatigues of manual labor would be added to those mental vexations from which the affluent are seldom exempt.

The young look to their superiors in years for counsel and instruction, and the aged to the vigor of youth and manhood for support.

A mutual dependance exists between the inhabitants of one clime and those of another; the wealth of one nation is comprised in its mines of silver and gold, that of another in the products of its soil. Those who depend on the latter may be considered as

peculiarly favored; for where the former exist, those arts which constitute the happiness and prosperity of a people are almost invariably neglected. From this circumstance, indolent habits, both of body and mind, are induced, and these in their turn generate many vices.

To the conquests of the Spanish in America, may be attributed the low state of morals, literature, and science, which prevails among them; for finding that they had acquired, with an extensive territory, a resource for the supply of all their wants, the natural advantages of their natal land were disregarded.

The advantages occurring from this system of mutual dependance are many; the division of labor, or the devotion of every man's talent to some particular trade or profession, is an economy, not only of time, but of health and of money.

Should one man engage in the pursuits which are now apportioned among many, much time would be lost in the acquisition of knowledge in various branches; his health would be impaired from the attention bestowed on them; his gain would not be in ratio to the expenses incurred; and no opportunity would be afforded of attaining to perfection in any.

From the consideration that we are continually reciprocating favors with our fellow beings, and that there are none so humble as not to be able to render us assistance in one way or another, we should be excited to kindness and humility; under the influence of so beneficent a system, the asperities of life should lose their keenness, and all the social feelings of our nature be expanded. M. O.

Friendship.—"When fortune smiles, and life is prosperous and fair, then it is that the nominal and true friend may seem alike sincere." Then it is that small and great, rich and poor, bond and free, bow at your shrine and prostrate themselves as it were at your feet. But when unfortunately the dark clouds of sorrow and disappointment gather thick around you, and you find yourself beset with troubles, losses, crosses, and disappointments, on every side, then you are ready to exclaim, "Fortune can create friends, but adversity alone can try them." Your friends of fortune will desert you. They will laugh at your misfortunes, and heap upon you shame and disgrace. They will sink you, if possible, lower, in point of honor and reputation, and in all your attempts to rise, cross and blight you at every turn.

But not so with the true friend. Though all your earthly prospects are cut off, he will not desert you, but if possible administer to your relief. Let us, therefore, cultivate and cherish that friendship, and that alone which will not diminish, though sorrows oppress and afflictions invade us: that too which will cheer and animate us amid our darkest hours and shine brightest in affliction's night.—[Monthly Repository.]

Synopsis of Meteorological Tables, kept at Rochester, N. Y., for the years 1831, 1832, and 1833.

Months.	Temperature.			Pressure.			Inches Rain.			Inches Snow.			Tem. Sp. Wa'r.		
	1831	1832	1833	1831	1832	1833	1831	1832	1833	1831	1832	1833	1831	1832	1833
January...	23.	26.4	31.4	29.45	29.56	29.42	.3	.9	1.4	15	15	11	37	39	35
February	23.5	26.	26.	29.70	29.63	29.51	.5	.4	0.0	33	29	35	36	37	37
March......	41.8	38.6	35.4	29.39	29.44	29.50	1.3	.8	.1	5	9	7	37	38	36
April........	47.5	47.4	52.5	29.38	29.48	29.54	3.8	1.5	1.8	2		1	42	41	41
May..........	59.7	57.2	62.	29.42	29.51	29.51	2.8	4.3	6.1	6			48	48	50
June........	71.6	70.3	62.	29.53	29.50	29.42	3.4	1.2	2.6				52	50	52
July.........	71.3	74.	70.9	29.49	29.50	29.51	5.4	4	3.8				58	54	54
August ...	71.	70.5	68.	29.61	29.60	29.49	1.2	2	2				60	56	56
Septembr.	60.9	62.8	63.5	29.50	29.54	29.54	2.4	1.7	1.5				57	56	55
October...	51.5	52.6	19.5	29.54	29.50	29.46	4.2	2 3	1.3				54	53	55
Novembr.	38.9	41.5	40.4	29.44	29.51	29.48	1.6	2.8	1	3	6	8	48	49	50
Decembr.	19.5	34.5	34.	29.49	29.47	29.56	0.0	2.4	1	13	13	14	40	44	42
Ann. Res.	48.3	50.1	49.6	29.49	29.52	29.49	26.9	24.3	22.6	77	72	75	47.4	47.1	46.9

Coldest and Warmest Days of 1831, '32, & '33.

Years.	Cold'st Day.	Warm'st Day.	Mean of ex
1831.	Feb. 7, 4° below zero	June 3, 95° above ze.	49.5
1832.	Jan. 27, 6° below zero	June 25, 88° above ze.	47
1833.	Jan. 17, 4° above zero	July 21, 91° above ze.	43.5

[Genesee Farmer.]

New Era of Steam Power.—In the December of the past year, we inserted several descriptions of improvements and projects respecting the application of steam power, and promised to continue to insert all that came under our notice worthy of recording. In order that our readers may be possessed of all the information that can be collected on this subject, we have introduced in this number eight pages of additional matter, and shall endeavor to give drawings in our next illustrative of some of the plans of the projectors which are now described.

Blanchard's Allegany River Steamboat. To the Editor, &c. &c.

Sir,—If, in announcing the twin boat on Burden's plan, it could have been stated that it had run up rapids so heavy in descent that a canal had been actually made around them, where the fall is in fact eight feet a mile, it would have been admitted that "a New Era" in steam navigation had indeed commenced; and this is but a correct description of the performance of *Blanchard's boat* on the Connecticut, between Hartford and Springfield, passing up Enfield falls, daily, the summer past.

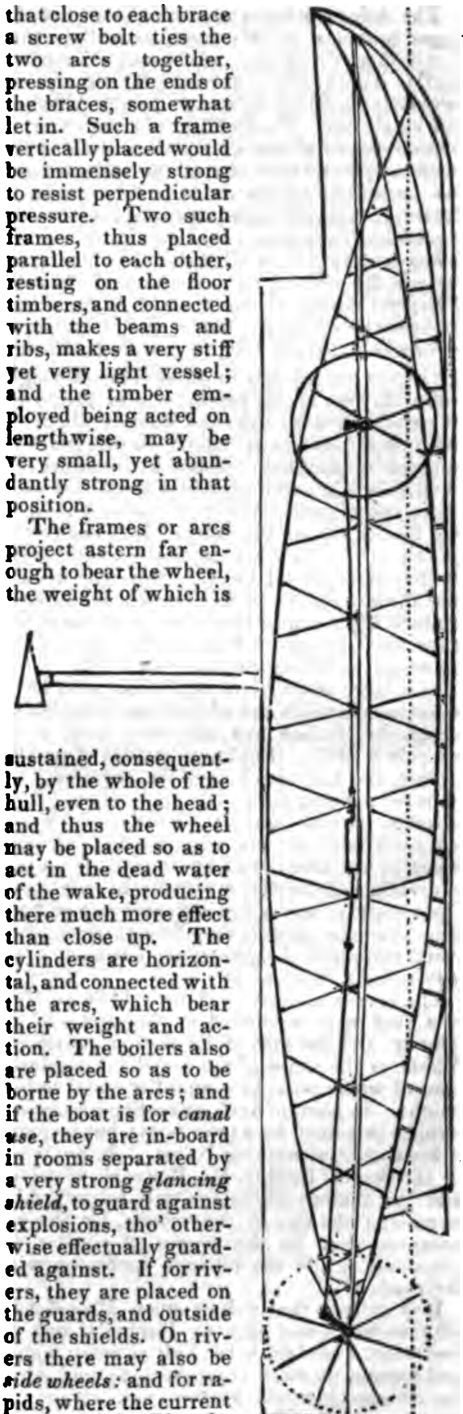
This sort of steamboat is the same that has made a passage up to Olean Point *from Pittsburg*. Others have since been built for constant business elsewhere: the Allegany route not yet being reached from New-York by the westward bound freight.

But I am led at this time to bring it into recollection and notice, as an *interested party*, from seeing, in one of your last numbers, mention of an improvement by Mr. Langdon, of Troy, in which some reliance appears to be placed on the principle of strength combined in Blanchard's patent.

The peculiarity of Blanchard's boat, which assures to it great speed, is the combination of means to construct a very light hull, having extraordinary vertical strength, so as to be able to carry a stern wheel, and *much more than usual power in proportion to size*. It may be said to combine ship carpentry and house carpentry with the principle of the arched bridge. This mode of construction, it will be seen by the annexed sketch, distributes the stress over the whole fabric. A great vertical force may bear on the arc frames; and if much longitudinal impulse is received, it is at their extremities. Even the cylinders of the engine are borne by these *arc frames;* and the *action and reaction* of the power is *all included within them*. The shell of the hull buoys up or carries the machinery, without being relied on to bear any strain.

Suppose two arcs of a circle of which the cord is rather longer than the length of the boat. Suppose them vertical and opposed, united at the extremities, and the curve preserved by braces in the form of an X; and that close to each brace a screw bolt ties the two arcs together, pressing on the ends of the braces, somewhat let in. Such a frame vertically placed would be immensely strong to resist perpendicular pressure. Two such frames, thus placed parallel to each other, resting on the floor timbers, and connected with the beams and ribs, makes a very stiff yet very light vessel; and the timber employed being acted on lengthwise, may be very small, yet abundantly strong in that position.

The frames or arcs project astern far enough to bear the wheel, the weight of which is



sustained, consequently, by the whole of the hull, even to the head; and thus the wheel may be placed so as to act in the dead water of the wake, producing there much more effect than close up. The cylinders are horizontal, and connected with the arcs, which bear their weight and action. The boilers also are placed so as to be borne by the arcs; and if the boat is for *canal use*, they are in-board in rooms separated by a very strong *glancing shield*, to guard against explosions, tho' otherwise effectually guarded against. If for rivers, they are placed on the guards, and outside of the shields. On rivers there may also be *side wheels:* and for rapids, where the current is too swift, Blanchard's invention to push or set the boat forward is applied. This is powerful enough even to lift while it pushes ahead, and is a combination very useful on the Ohio in a low state of the water.

The Allegany boats can use the coal of the upper branches of this river, as well as that obtained at Pittsburg. A branch railroad to Buffalo would carry coal to the lake boats. A twin boat would not be so safe for the Allegany as a single one. The liability of a twin boat to strike aground, or against another vessel or obstacle, suddenly with *one* of the hulls, causes the *momentum of the other* (a force equal to the weight thereof multiplied into its velocity) to rend itself separate. And two hulls that are so heavy as to sink, if filled, doubles the danger, because the sinking of one upsets the whole. Whatever depresses one more than the other, disturbs the steering; but a single hull may heel without diminishing the power of the helm.

It seems reasonable to think that a single hull, with very ample power, will be the swiftest vessel, because she may receive the form and proportions nearly which Nature gives to quick swimming fish. Naval architecture has taken this hint, and follows it out as far as is consistent with the stability of sailing vessels. One that is shaped the same at both ends cannot sail as well as when gradually diminishing aft from the forward *third*. Since the resistance to the velocity is well known to increase in much higher ratio than the speed, the lighter the draft the greater promise of rapidity, as flat vessels sail fastest before the wind.

On a large scale, Blanchard's boat may have uncommon breadth and adaptation to the Ohio; and on the Hudson she may have both stern and side wheels. The more breadth of paddle applied, the less depth will be required, and the more advantageous the application. The cylinders may be upright for the side wheels, and horizontal for the stern wheel; all sustained by the arcs: and by thus distributing or dividing the power, more may be employed. The weight of an engine increases in a greater ratio than the power, therefore three engines would comprehend a greater proportion of power to weight, than one or two.

The resistance sustained by a body moving in a fluid is proportioned to the square of its velocity, and the area of its section immersed. Whatever the shape of the vessel, her displacement of water must be a quantity equal to her weight. In point of draft, or section immersed, nothing is gained by a twin boat; but in point of resistance, something is lost. In his work on the Steam Engine, Mr. Renwick observes that "an obvious advantage will be gained by increasing the size of the vessels, for the resistances vary as the *square* of similar dimensions, while the *tonnage* increases with their cubes."

It is evident that a boat upon Blanchard's plan, as broad and long as Burden's, and 32 feet wide, would draw but half as much water, and present no more cross section; and while the resistance would be the same, minus the friction of two sides, she would have the advantages of not parting the water at so much depth, and of avoiding by her shape the retarding force following or occurring at the stern. Burden's are 8 feet diameter.

For these reasons mainly, which are in their nature indisputable, I am led to think that Blanchard's kind of boat with stern and side wheels must be very favorable to the effect of the power, since with that of the stern wheel only, they perform so well.

Humble as may be the instrument described in this article, it can hardly be doubted from experience thus far, that it really commences a "*new era*" in the art, when steamboats will conquer the difficulties of rapid rivers, and combining the means of safety, traverse the great arc of the Union, from the head of the Allegany to the head of the Tennessee.

J. L. Sullivan.

Capt. Davis Embree, of Cincinnati, Ohio, has furnished us with the following description of an improvement in low water boats, that he is about to put in operation on the Ohio. He says he can lessen the draught of water at least *one-fourth*, while he retains the usual strength, speed, and convenience for freight and passengers. He says he will at the same time introduce the principle of the *life-boat*, and render it almost impossible to sink the boat by snags, rocks or waves.

The boat he is about to build will be 135 feet in length, and 24 feet wide; the hull will be 3 feet 3 inches deep. The beam of the boat will be shaped like the bowl of a table spoon, so as to rise over the water. Twenty-six feet from the stern there will be a recess on each side, of 6 feet, for the wheels to work in. The boat will be reduced there to 12 feet wide. Aft of the wheels there will be a clean run, and transom stern. This narrow part is intended to bear up the wheels and other machinery, and to furnish room for a stern castle, with its capstan, anchors, and other rigging, so essential on that part of the boat, as well as on the bow, when a boat is run in low water. By this arrangement, the wheels of the boat can be thrown out of gear, as well as other side wheels; they have all the advantage of working in eddy water, or a counter current, of the stern wheels. They have not the propensity to *break down* the stern of the boat, which is always attendant on wheels placed *behind* a boat. That part of the hull, which would otherwise be weak, in consequence of the recesses, will be supported by the cylinder timbers, and the bulkheads under them.

The hull of the boat will in the first place have three main bulk-heads, running nearly its whole length, which will divide it into four parts: these bulk-heads will be made of 1¼ inch pine; they will be notched over the floor timbers and be fastened to the bottom plank; they will extend to the deck: there will then be ten cross bulk-heads, made of inch pine, placed 9 feet apart, made also water-tight, which will make forty water-proof rooms, 6 feet wide, 9 feet long, and 3 feet 3 inches deep. There will be in each of these rooms two stanchions, placed 3 feet apart, and 3 feet from the bulk-heads, upon the floor timbers, and under the beams. Thus there will be a bearing at

every 3 feet in every direction throughout the boat, between the bottom and deck. Then, to secure it more firmly, there will be 160 tie-bolts passed through the bottom, along side of the bulk-heads, and through the deck. This arrangement will give such great strength, that the timbers may be small; they will be made of selected young white ash, as tough as whip stocks. The floor and upright timbers will be but 3½ inches square. The beams (except for the boilers and wheels) will be 2½ inches thick and 4½ wide, bent over the main bulk-heads, and made to extend about 1 foot over the sides of the boat, to form a narrow guard. The bottom plank will be 2 inch oak; the side plank the same; the deck will be 1½ pine; the timbers or scuppers, to drain the bilge water to the pump, will be made by grooves in the bottom plank, so as not to weaken the timbers. The floor or bottom of the boat will be nearly flat, the nuckle nearly square, the sides will flare but 4 inches outwards. There will be small hatches into each room of the hull, to go into it, to stop scuppers or leaks, when required, so that if a snag run through the boat in any direction, so as even to destroy ten of these rooms, there will be still thirty left to buoy up the boat. She cannot sink but by great negligence. This is perhaps the most important feature presented by the plan; but when, in addition to this, we have a boat of full strength and speed, and containing all the usual convenience for freight and passengers, improved from 25 to 30 per cent. in draught of water, we have all that could be reasonably looked for. The boat is supposed to draw but 15 or 16 inches of water with her wood and water aboard, and then it will take nearly six tons to sink her one inch.

The hull will not be suitable or convenient to carry engine, freight, or passengers, within its body. It will be a single buoyant mass, made of light and strong materials; it will be a mere *float*. The first or lower deck will be appropriated for engine and freight, the upper deck for passengers; the cabins will be 16 feet wide, with an outer guard on each side 4 feet wide; the ladies' cabin will be 18 feet long; the main cabin will be 33 feet; the office and pantry 6 feet; and the room for crew and deck passengers 30 feet, with a guard in front. The engine will be of common construction; the boilers will be placed near the middle of the main bearing part of the hull. There will be two boilers, 40 inches diameter, 19 feet long; two flues, each, 15 inches in diameter; the cylinder will be 16 inches diameter, with 4½ feet stroke of piston: it will have a slide valve and puppet cut off. The water wheels will be 13 feet in diameter, with a bucket 6 feet long.

New Steamboat.—We copy from the "Troy Budget" an account of another invention, which report says will supersede Mr. Burden's. We have sent to the inventor, requesting him to furnish drawings and descriptions of his plans, and hope shortly to be able to lay them before our readers. It consists, we understand, of two boats, and a third may be added—300 feet long, and decked over their whole length. Each boat, in shape and mould very much like the Indian bark canoe, is firmly secured by arches attached to the bottom and passing up through the deck, about 20 feet high in the centre, extending nearly the whole length of the boat. The appearance of the boat is pleasing, and is acknowledged by competent practical scientific judges to be far superior to any thing yet in the shape of a steamboat. Mr. Langdon intends to finish the boat in a superior style, with two cabins of 200 feet each, dispensing with the promenade deck and every thing necessary for its support. On the main deck, the only one required, he also intends to have two horizontal engines, one each end of the shafts, the cranks being placed at right angles. The boiler will be constructed like the one which is in operation at the steam-engine works of Langdon, Grosbeck & Co., West Troy, for burning anthracite coal. The boiler is very economical in its consumption of fuel, and is a rapid generator of steam. Mr. L. is of opinion that one firing will be sufficient to carry his boat from Troy to New-York. We have seen the boiler, and it certainly appears, like the boat, to be superior to every thing of the kind in the country.

The boat is an interesting and ingenious specimen of mechanism, combining great strength and durability, with a spacious deck and extensive cabins. Its buoyancy and dimensions, united with the perfect safety attending it, together with the superior accommodations which can be furnished, when put in operation, will bring about a new era in the history of travelling by steam. Mr. L. has secured a patent, and intends to have his boat in readiness for use in the course of the next summer.

Mr. Langdon is not unknown to the public as a worthy and skilful mechanic. He is the inventor of the Horse Ferry Boat, which has come into very general use. We wish him the completest success in his new enterprise.

Another Steamboat.—This is emphatically an age of steam inventions. New steamboats, steam-boilers, and steam-engines, greet us on every hand; and in this neighborhood there seems to be an astonishing fecundity in this respect.

Mr. Burden's wonder was long ago duly announced, and intelligence of it has been carried by the four winds to the four quarters of the globe. Not long since, some unknown friend sent us a paper printed in Ireland, containing an account of Mr. Burden's invention, originally given in this paper.

We have also noticed, upon the authority of others, Mr. Langdon's invention, and owe him an apology (which we find in the multiplied duties of the conductor of a daily paper), that we have not yet embraced his invitation to examine his boat.

Our object now is, as chroniclers in this region, to inform the public of another invention or model of a steamboat, which, being exhibited in this city, we had the pleasure of seeing on Tuesday. The plan is approved of by several prominent individuals in this city, who, besides, are connected with the present steamboat association, and who, we understand, design, (such is their confidence of its merits,) at no distant day, to reduce the invention to the test of experiment.

The model, which is remarkable for its simplicity and the absence of *extra* and unnecessary incumbrances, represents a boat 250 feet long, and 50 feet wide, composed or built upon two hulls (each 250 feet long) lying parallel to each other, and 20 feet apart in the centre.

The hulls are designed to be 10 feet deep, and 11 wide, with perpendicular sides, so that, at the same time they serve to buoy the boat, they supply two long and spacious cabins; which being below and not above the deck, will obviate the hindrances to speed, which boats having their cabins and a load of fixtures on deck, in certain states of wind and weather, sometimes experience.

The deck is arched, and in such a way, if not to present the full resistance and power of the perfect arch to the weight that may be placed upon it, yet so as in a great degree to strengthen the boat, and render it fully adequate to the uses for which it is designed.

The sides and bottom of the hulls, where they come in contact with the water, are constructed on a line purely designed to diminish resistance, and forming the segment of a circle of an immense diameter.

The boat is to be propelled by a single paddle-wheel of great power, revolving in the centre between the hulls.

The inventor is a young man of this city, of promise and ingenuity, and the present evidence of it is not the first the public has to judge from. His profession and calling have given him opportunies of observation, and of studying the subject of improvements in the application and use of steam and steamboats, which few others have had, and which, with a laudable ambition, he has endeavored to improve for the benefit of the public, and we hope of himself also.

It is also intended to introduce a coal-boiler, constructed on a new principle, the effect of which, it is assumed by those acquainted with the subject, (which we profess not to be,) will be the saving of at least 50 per cent. in the expense of fuel.

To construct a boat 250 feet long, it is estimated will cost $30,000.

The hulls will be framed upon light but strong timbers, upon which are to be fastened successive layers of thin tough oak plank, or boards. The first layer to run horizontally lengthwise the boat; the second crosswise; the third crosswise diagonally; and the fourth lengthwise; the whole fastened or riveted together, by iron nails or rivets, and to constitute a thickness not exceeding four inches: forming, in short, a kind of medium between boats built on the plan of Mr Annesley and common boat building.—[Troy Press.]

IMPORTANT DISCOVERY.—A gentleman in this town believes he has discovered important improvements on the Burdenian plan of constructing steamboats, which he conceives will eventually supersede every other mode now in use. The improvements, it is thought, will combine every advantage of the Burden plan as to speed, and 1st, a great increase of strength —2d, a much less draft of water—3d, an adaptation to lake or river navigation, in deep, shallow, calm, rapid, or rough water—4th, an adaptation to the conveyance of passengers, or both freight and passengers, affording abundant room for the stowage of freight, which Mr. Burden's plan does not embrace—5th, an increased facility in turning round—6th, a great diminution of cost in the construction. It is supposed that a boat on this plan may be built, which will run as fast as the boat built by Mr. Burden, having the same power of engine, and draw not more than one and a half or two feet of water. Should the sanguine expectations entertained of the value of the improvements, upon further consideration, prove well founded, a further notice will probably appear.—[Brockville Recorder.]

From the Montreal Gazette we extract the following:

Norman Bethune, Esq. of this city has obtained letters patent for a new improved principle for building steam-vessels. Of course we are unaware of the exact nature of Mr. Bethune's improvement, but he has stated to us that ever since the completion of the Manchester and Liverpool railroad, his mind had occasionally been engaged in devising some improvement in the speed of steam-vessels, but that owing to his avocations he had not leisure to give much attention to the subject. He had thought of the buoyancy of the cask, but did not discover the application of it until he read a description of Mr. Burden's new boat, which seemed to promise what he had been in search of. But upon carefully examining it, he discovered a great deficiency in safety to the passengers and cargo, in the event of an accident happening to one of the tubes, by striking a piece of floating timber or ice, end on, while under full impetus, which would cause that side to fill almost instantaneously, and the weight on deck would sink it in a few minutes to the bottom; but where the depth of water should be greater than the breadth of her deck, she would fall over on her back. To obviate such a risk has for the last four months been his study, and he has, in his opinion, happily arrived at a complete safeguard against such an accident; and in attaining that desirable end, his boat naturally acquires greater buoyancy, and of course greater speed.

Mr. Bethune feels perfectly satisfied that a vessel built on his plan will make the passage to Quebec in eight hours, and return in ten, stoppages included. Should his views prove correct, two boats, built upon the new plan, would form a daily line, and starting at six o'clock in the morning from both places, the Montreal boat would land her passengers at Quebec at two o'clock, and the Quebec boat here at Montreal at four o'clock in the afternoon, (taking the tide as it might happen to be,) and always in day-light.

New Method of applying Steam Power.—Mr. Brown, of Keeseville, has stated that he has invented a plan by which he proposes to dispense altogether with the use of an engine, thereby not only saving the important item of fifteen thousand dollars in the expense, but moreover the cumbrous bulk and ponderous transportation of an engine. He has entire confidence in the perfection and utility of this discovery, having tried the experiment "on a small scale;" and is taking measures to patent his invention, and to demonstrate its capacity early the coming season. Mr. Brown is an ingenious mechanic and worthy citizen of our village. Thus, with Burden's boat, Rutter's process of generating steam, and Brown's application of its power, we may soon expect to ride from Troy to New-York and back in *twelve* hours, and at an expense less than we could stay at home in "these hard times."—[Keeseville Argus.]

Mr. Burden's Steamboat.—In the description of Mr. Burden's experimental boat, (see Vol. II., p. 308,) we stated that the boilers were made under the direction of Dr. Nott. We since learn that they were constructed on the principle of the locomotive boiler in common use, under the direction of Mr. Hall, engineer, of the West-Point Foundry. In these boilers the *flame* passes through a number of small copper tubes, while in Dr. Nott's boilers the water circulates through the tubes. We also understand the latter plan will be shortly tested in a new boat for the Jersey ferry, when its comparative merits will be ascertained.

Steam-Carriages on Common Roads; with a Notice of the Journey to Stoney Stratford. [From the Repertory of Arts, &c.]

We are not disappointed in the expectations we hold out, that "steam-carriages might soon be expected on our common roads," a company being now formed for improving the roads, and running steam-carriages between London, Birmingham, Liverpool, and Holyhead: to be called the "London, Holyhead, and Liverpool Steam-Coach and Road Company," Consulting Engineer, Thomas Telford, Esq., Acting Engineer, John Macneill, Esquire.

From the moment that Sir Charles Dance introduced his carriage to Messrs. Maudslay and Field—and those gentlemen saw enough to induce them to undertake to make repairs and changes in the practical details—we were satisfied that the day was not far distant when this description of conveyance would become general; and it only required that the old carriage should be vamped up sufficiently to perform a journey of some extent, carrying such parties as could duly appreciate the performance; and who, from their practical experience, would judge whether sufficient had been done to justify them in lending their characters in the future advancement of this important project. The Brighton journey, from the admirable manner in which it was performed, naturally turned the attention of scientific men to the subject; and the regular running of the carriage between London and Greenwich for eight successive days (Sundays excepted), added to the general feeling, that enough had been accomplished to warrant that more decided steps should be taken to advance the introduction of steam conveyance on our common roads. Hence it was proposed by a number of influential individuals, that a further trial should be made of the engine, with a view to forming a company between London and Holyhead, should Mr. Telford and other engineers be of opinion that the application of steam on common roads had become practicable; and a proposition was made to Sir Charles Dance, that his steam-coach should run to Birmingham. We have already expressed our opinion that the carriage had performed more than could have been expected, from the inequality of many of its parts; and it would probably (as far as the public opinion was concerned) have been desirable not again to have put the carriage on the road; this was the opinion of many, particularly of Sir Charles Dance himself. The liberal manner however in which Mr. Telford and other engineers and scientific men had taken up the matter, and had tendered their talent to bring the carriage before the public, at once induced Sir Charles to give his approbation to the journey, more particularly as the engineers gave it as their opinion, that although they might not arrive at Birmingham, owing to the state of the carriage, together with the badness of some parts of the roads, they would be equally well able to form a decided opinion from what the present carriage was capable of performing, as to what more might be ex-

pected from a new carriage built by practical workmen, and with due attention to the proper distribution of strength. The question to be decided was, whether the principle was good; if, after a fair trial, the answer should be in the affirmative, then there would be no doubt that, placed in practical hands, engines would be produced capable of performing with as much certainty as any other means of conveyance, and with an increased degree of speed and safety: on the other hand, should the opinion prove unfavorable, and the principle be considered defective, this knowledge must have determined Sir Charles Dance on abandoning all further attempts to realize his great undertaking. Having given these introductory remarks, we cannot but express our pleasure in recording the liberal manner in which the engineers and other scientific men have come forward to advance so great a national undertaking, and by their characters and talent have given weight to the cause in which Sir Charles has so long, so arduously, and we may now add, so successfully labored. We are happy in being able thus to state, that the question of the practicability of steam conveyance on our present roads is now set at rest; because we are aware that many and various reports have gone abroad with respect to the Birmingham trip; but we doubt not that the results which we have given will show, that what was performed on that day convinced all parties present that enough had been done.

We will conclude our notice of this subject, by giving a few particulars of the journey of the steam carriage from London to Stoney Stratford, taken from the note book of one of the gentlemen present. "On Friday, the first of November, 1833, Sir Charles Dance's steam carriage started from Gray's Inn Road, at about twenty minutes after three o'clock, A. M., passing through Highgate Archway, arrived at the Wellington (between five and six miles) in thirty-three minutes, the road being on the rise all the way. At this place coke and water were taken in. When again about to start, it was discovered that the weld at the joint of one of the tubes had given way, and that the water was flowing copiously; the carriage was run into the yard, and the fire put out, in order to repair the defect. Mr. Field, on examination, directed the man to cut out the defective part, and plug the ends; this was a work of time, owing to the want of tools. The object however was accomplished, and after four hours' delay the fire was again lighted, and the carriage once more took the road, and without further accident arrived at Stoney Stratford, fifty-two miles; at which place it was determined to dine and stay the night, and proceed forward next day to Birmingham. In the morning, on lighting the fire, it was discovered that the pipe was still defective, and would require to be removed, that good joints might be made; this must necessarily cause delay. On a conversation of the parties it was generally agreed, *that the practicability and economy of employing steam carriages as a means of transport for passengers on turnpike roads was fully established.* The carriage remained at Stoney Stratford on Sunday, and was to have returned to town on Monday; but there being a meeting of magistrates and commissioners of public works on that day, who expressed a desire of seeing the performance of the carriage, it was determined to delay the return till Tuesday, on which day it came to town, a distance of fifty-two miles, in four hours and forty-five minutes, even with the bad state of the roads.

"We have with pleasure spoken of the liberality of one party of individuals, we cannot pass over in silence the illiberality of others. Immediately on its being determined that the steam carriage should go to Birmingham, Mr. Macneill (one of the engineers of the Holyhead roads), assisted by Mr. Gordon, undertook to make arrangements for supplies of coke and water at proper distances; by this means it soon became generally known that the carriage was expected; and in addition to the already bad state of this portion of the roads (the St. Alban's trust), soft gravel to the depth of ten inches was laid over many parts, with a view to stop the carriage; but we leave this disgraceful conduct to receive its proper notice in the annual report to government of the commissioners and engineers of the roads. With the exception of this trust, the most liberal feeling was displayed by all parties and every facility afforded."

One of the principal roads having thus been taken up, and countenanced by some of our most celebrated engineers, leaves no doubt that attention will soon be called to other roads. An important benefit attending improving the present roads is, that the course of the traffic will remain unaltered; and thus the immense interests embraced on the "road sides," throughout the country, will retain and perhaps increase their value.

The subject of road making becoming thus a matter of the greatest importance, we hope to be able to give some particulars of the improvements which have been judiciously made on the Holyhead road; and we shall be happy to receive any information on this

subject from our correspondents; for we are anxious to see every possible improvement introduced in our means of conveyance, whether on canals, railways, or common roads; we are advocates for all, for each means has its advantages; and we do not hesitate to say, that England is as much indebted for her prosperity to the facility of conveying her produce, as to any part of her economy.

Since writing the above, we have been favored with a copy of the report of the engineers who accompanied the carriage, which we subjoin.

Report of the Result of an Experimental Journey upon the Mail-Coach Line of the Holyhead Road, in Lieutenant Colonel Sir Charles Dance's Steam Carriage, on the 1st November, 1833.

Public attention having been attracted to the practicability of travelling with locomotive engines upon ordinary turnpike roads, by a report of a Committee of the House of Commons, of the 12th of October, 1831, stating that, in the opinion of the committee, the practicability of such mode of travelling had been fully established; and more recently by a report of a journey to and from Brighton having been successfully performed by Lieutenant Colonel Sir Charles Dance's steam carriage, as well as by the fact that the same carriage was daily in use between London and Greenwich, conveying numerous passengers through the crowded suburbs of the metropolis without the slightest inconvenience to the public, we were desirous of personally making an experiment of the facility with which a carriage of that description could perform a journey of considerable length; and having selected the mail coach line of the Holyhead road for the purpose of such experiment, we made an arrangement with Sir Charles Dance for the use of his Carriage, on Friday, the 1st inst.

*The weight of the carriage, with the water, coke, and three persons upon it, was about - - - -	3 tons, 5 cwt.
The weight of the omnibus coach attached to it -	1 " 0 "
The weight of the passengers, their luggage, and some additional sacks of coke, about	1 " 15 "
Making the gross weight moved,	6 tons, 0 cwt.

The motive power was an engine with two cylinders, seven inches in diameter and sixteen inches stroke. The pressure of steam on the tubes constituting the boiler, or generator, was not allowed to exceed 100 lbs. per square inch.

Before the carriage had proceeded six miles, one of the tubes of which Sir Charles Dance's boiler is composed was found to leak so fast as to render repair absolutely necessary: it was also apparent, that the size of the engine was not sufficient to carry so great a weight along a heavy road at any high velocity.

The weather was by no means favorable, there having been much rain in the course of the night and morning, so as to make the road heavy, added to which the winter coating of new materials had, in many places, been laid upon the road. Notwithstanding these obstacles, upon our arrival at Stoney Stratford, 52½ miles from town, it was found by Messrs. Macneill and Carpmael, who had taken accurate minutes of the loss of time occasioned by stoppages, that the average rate of travelling had been seven miles per hour.

Thus there can be no doubt, that with a well constructed engine of greater power, a steam carriage conveyance between London and Birmingham, at a velocity unattainable by horses, and limited only by safety, might be maintained; and it is our conviction that such a project might be undertaken with great advantage to the public, more particularly if, as might obviously be the case, without interfering with the general use of the road, a portion of it were to be prepared and kept in a state most suitable for travelling in locomotive steam carriages.

Thomas Telford, President of the Society of Civil Engineers.
John Rickman, Secretary and Commissioner of Highland Roads and Bridges.
C. W. Pasley, Lieut. Col. Commanding the Royal Engineers, Chatham.
Bryan Donkin, Civil Engineer.
Timothy Bramah, Civil Engineer.
John Thomas, Civil Engineer.
Joshua Field, Civil Engineer.
John Macneill, Engineer to the Holyhead Roads.
Alex. Gordon, Civil Engineer.
Wm. Carpmael, Civil Engineer.
J. Simpson, Engineer to the Chelsea Water-Works.

London, November, 1833.

We shall now subjoin a list of locomotive engines, completed and building in England, taken from the report of the committee appointed by the British Parliament.

* These facts have been ascertained by Mr. Joshua Field, Mr. John Macneill, and Mr. Alexander Gordon, civil engineers.

Locomotive Engines—Historical Retrospect. Compiled from the Report of the Committee of the House of Commons, of August, 1831.

The first locomotive engine was invented twenty-eight years ago, by the late Mr. Trevithick, a very ingenious man, and subsequently improved and used by Mr. Blenkinsop and others, for the service of collieries.

Mr. Gurney stated that his carriage weighed only 2¼ tons; that in 1825 he began to work it;
that in 1826 he went up Highgate and other hills; and in 1827 he went to Bath.
that he has run 18 to 20 miles an hour.
that he is able to compete with the coaches, with an advantage, as 2*l.* 10*s.* to 15*s.* per hundred miles.
that he makes no noise.
N. B.—Mr. G. run his carriage for some time between Cheltenham and Gloucester, to the great loss of his supporters, Sir Charles Dance and others.

Mr. Hancock stated that his carriage weighed 3½ tons,
that, with a piston of 9 inches, he has worked at 400 lbs., and on an average at from 60 to 100 lbs. on the square inch; consequently, could exert a power of 13 to 90 horses.
that he makes only one-third of the noise of others.

Mr. Farey stated that Mr. Hancock and the Messrs. Heaton were the only candidates likely to prove successful.
suggested that there should be 2 horses at every hill, for the help of these locomotives.
stated that passengers were annoyed from heat, noise, smoke, and dust.
condemns Gurney's, &c.
N. B.—The Messrs. Heaton, residing at Birmingham, were not examined.

Mr. Ogle stated that his engine is 20 horse power, with a pressure of 250 lbs. on the square inch.
that his carriage weighs 3 tons.
has gone at the rate of 32 to 40 miles per hour —and has ascended hills at the rate of 16½ miles per hour.
explosion impossible.
he is on the point of establishing a factory, *so great are the demands for his carriage!*

Mr. Gibbs was very sanguine in his hopes of success —proposed to plough, and drive vans.

Mr. Summers (the partner of Mr. Ogle) stated that they had constructed 2 carriages, weighing 3¼ tons, besides passengers.
that they had carried 9 persons at the rate of 9 miles, when the crank broke, and the carriage was sent back by canal.
has carried 19 persons at the rate of 10 miles.
has travelled at the rate of 30 miles during 4½ hours frequently; consequently 135 miles in 4½ hours.*
has ascended Shirley-hill, which is 1 foot in 6.

Such was the state of the locomotives in 1831.

Observations.—In 1833, Mr. Gurney, the most persevering of all the competitors, is beaten out of the field, to his great cost.

Sir Charles Dance, his substitute, has run many times to Croydon and Greenwich—made an attempt to go to Birmingham, in which he failed—and made, lastly, an attempt to run daily to Clapham, in which also he has failed.

Messrs. Hancock, Ogle, Gibbs, Summers, and Heaton, are all in movement, but merely by convulsive starts; although they are provided with powers that may be raised to twenty, thirty, forty, and eighty horse power.

About twenty years have passed away in experiments, and not less, probably, than 100,000*l.* have been expended upon them; yet, after all, nothing effectual has been done.

At one period steam guns were the terror of many: they were to have mowed down whole ranks of infantry and cavalry; even artillery were to be quite impotent before them; but nobody now hears or dreams of such things. It would almost seem as if steam-carriages were destined to run the same course. The writer hopes not; but if he were to look for grounds to anticipate a different result, it would not be in any of the prospectuses for steam-carriage companies that he has seen, of which the best that can be said is, that they circulate much easier than the wheels of the carriages that they respectively extol to the skies.

A Frenchman.

List of Steam-Coaches and Drags now building and built in London and its Vicinity.

We have been favored with this list by a correspondent, who states that its "accuracy may be depended on." We really had no idea that there were so many locomotive competitors in the field.—[Ed. M. M.]

Hancock	1	Infant, his own, built, experimental one.
Ditto	2	Era, (for a company,) built.
Ditto	3	Enterprise, (ditto,) built.
Ditto	4	Autopsy, his own, built.
Ditto	5	a new one now building, his own
Gurney, Maudsley, Stone, and Gibbs	1	a drag, built and altered by the said engineers, for Sir C. Dance, Knight.
Ogle	1	a carriage, his own, built, experimental one.
Squire	1	a carriage, himself and others, experimental one.
Frazer	1	a carriage, himself and others, building, experimental one.
Gibbs & Applegath	1	a drag, themselves, experimental one, built.
Gatfield and Bower	1	a drag, themselves, experimental one, building.
Andrew Smith	1	a drag, (for Mr. King,) experimental one, building.
Palmer	1	a drag, his own, experimental one, built.
Redmund	1	a carriage, experimental one, building.
Manting, Joseph,	1	a carriage, his own, experimental one, building.
Phillips & Co.	1	a carriage, their own, experimental one, building.
Silk	1	a carriage, his own, experimental one, building.
Smith and Co.	1	a carriage, (for company,) experimental one, building.
Mile-end, (name not known)	1	a carriage, (for a company,) experimental one, building.

The application of steam to agricultural purposes is said to have lately called forth a powerful and effective engine in France; and it has at the same time produced a steam digging machine in England.

* Mr. Summers afterwards explained that what he meant to say was, that he had travelled "for the space of four *miles* and a half—not four *hours* and a half—at the rate of thirty miles an hour."—[Ed. M. M.]

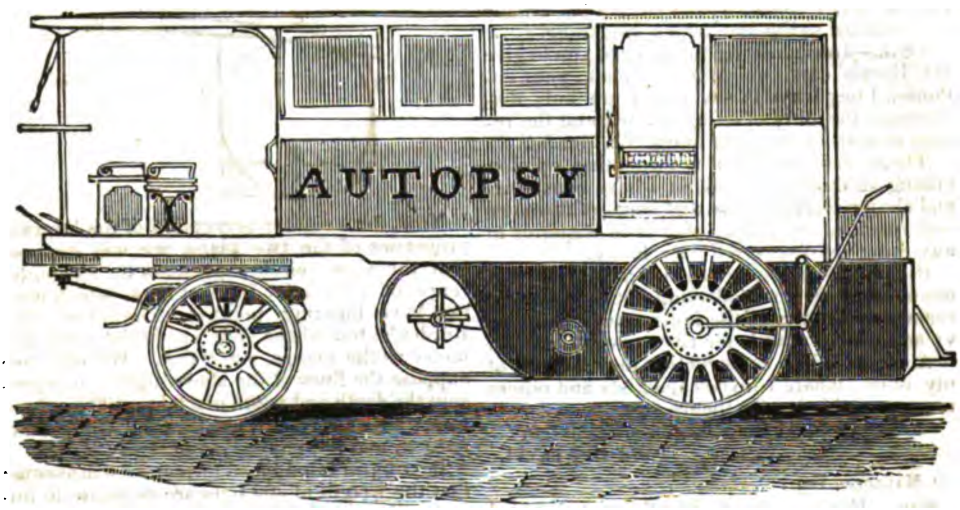
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] MARCH, 1834. [NUMBER 3.

Books that you may carry to the fire, and hold readily in your hand, are the most useful after all. A man will often look at them, and be tempted to go on, when he would have been frightened at books of a large size, and of a more erudite appearance. —DR. JOHNSON.



HANCOCK'S STEAM-CARRIAGE "AUTOPSY."—We give an engraving of Mr. Hancock's last new steam-carriage, the "Autopsy,"—the same which performed the journey to Brighton and back, with so much success, about three weeks ago, and which has been running daily, during all the present week, between Finsbury square and Pentonville. We have witnessed its performances repeatedly, both as passengers and as lookers-on—and only re-echo the general opinion, when we say that it works admirably. The machinery, which is constructed on the improved plan, for which Mr. Hancock's last patent was taken out, will be found fully described in a subsequent communication from Mr. Hancock himself.

The quantity of coke expended in each journey of (about) two miles, scarcely exceeds a bushel; so that even supposing the tear and wear were to be as great as in the case of Mr. G. Stephenson's engines on the Liverpool and Manchester Railway, or even twice or thrice as great, the returns from such a carriage, running between the City and Pentonville or Islington, must be sufficiently ample to afford a very handsome profit. According to the following calculation, with which we were favored by a fellow-passenger, there would be a clear gain, during a period of 365 days, of nearly cent. per cent.

CAPITAL REQUIRED TO BE INVESTED.

Cost of steam-carriage	£700
Spare ditto, to use when the other is under repair,	700
	£1,400

Dr.

Wages—engineer 40s. per week, steersman 30s. assistant 20s.	£234
Repairs	150
Tolls 4d. each journey × 12 × 365	73
Coke 6d. per journey × 12 × 365	100
Water	50
Rent of coach office and coach house	100
Clerk	50
Premium to the patentee, at the rate (say of 1d. per passenger) 12 × 24 × 365	438
Reserve Fund to replace carriage when worn out—probably in 3 or 4 years	175
	1,452
Dividend of £84 on £1,400	1,176
	£2,628

Cr.

By twelve journeys per day, and twelve passengers each way, at 6d. each, 12 × 24 × 365, - - - - - - - - - - £2,628

[London Mechanics' Magazine.]

We have received the following communication from the agent of Mr. Harris, respecting his invention, and on the same day the letter from our friend Archimedes. We have often stated that our columns are open to controversy on scientific subjects, if conducted without personalities, and we cheerfully insert both articles. We hope to receive other letters on the same subject.—[Ed. Mec. Mag.]

Harris' new Patent Twin Steamboat. To the Editor of the Mechanics' Magazine.

Sir,—In requesting the favor of you to give Mr. Harris' communication a place in your columns, I beg leave to say that I am only discharging the duty of an agent, without the remotest wish or desire to injure Mr. Burden.

There has not been a dissenting opinion among all those with whom I have consulted, and shown Harris' plans, and some of them are well qualified to judge, that it is superior to any thing yet discovered for velocity.

His invention admits of many advantages not enumerated in the following letter. Among them are, security of the *inner* wheels in a heavy sea, double wheels for river navigation, &c.

A model of the construction may be seen at my office, where I invite capitalists and others to come and judge for themselves.

D. Mallory, Chester's Buildings,
No. 1 Dey street.

D. Mallory, Esq.:

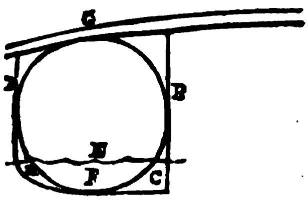
Sir,—Having for some months past observed in the papers notices of "Burden's Steamboat," and of the very great velocity with which she is expected to move, I was induced to institute a comparison between his construction and one which I invented, and have secured in the patent office at Washington; and the result is, that a boat built on my plan must move with greater velocity.

If I can establish the fact—which is the object of this communication—that a boat constructed on my plan, of equal length, and of as much weight as his, possessing a form calculated to move with less obstruction from the water, and to draw considerably less water than his, it must be manifest that my plan is superior, and must supersede his.

Before entering upon a comparison of the two plans, it is necessary that I should give you an idea of the form of my boat. You have only to imagine a boat *extremely long*, *very narrow*, with a flat bottom, similar to river steamboats of the present day, and *very sharp*, with *fine tapering extremities*, with the stem and stern posts in a curvilinear shape, and both inclined in opposite directions, as in common vessels, but at a very acute angle with the horizon. You have now only to conceive this boat split into equal parts, longitudinally, from stem to stern, down through the keel, and the two halves placed at any desired distance from each other in parallel lines, but joined above water by timbers and deck in the most substantial manner, and you have my plan.

I will now proceed to prove the superiority of such a construction over Burden's boat.

The *lines* of the figure marked A, present an end view of one of my twins cut *across* and *entirely through* at the centre, thereby showing the shape of the timbers or model of the twins, at the centre; the side timber, B, being 8 feet long, that is, that portion of it contained between the side timbers B and D. Within this figure is inscribed a circle of 8 feet diameter, representing an end view of one of Burden's twins, severed across at the centre also.



Now, for a clearer perception of the buoyant properties of the two plans, we will suppose that the above circle represents the circumference of a cylinder 100 feet long, which does not have tapering, pointed extremities, like Burden's, but whose ends are of the same diameter as the centre, viz. 8 feet. We will also suppose the lines of the above figure to represent the depth and width of a fabric 100 feet long also, whose ends shall have the same dimensions (8 by 8) and not pointed, as after my plan.

Bearing in mind these forms, we will assume that the weight of 200 tons are requisite to immerse the circular figure 2½ feet in the water, the surface of which is represented by the water line E.

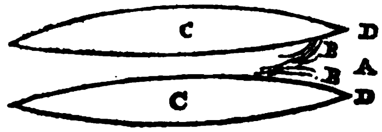
Now, a simple inspection of the two figures will suffice to show that 200 tons could immerse the black lined figure hardly more than half that depth, because, besides immersing an area equal to the segment F, it would have to immerse also the two areas G and H, which, together, are equal to ⅓, and a little more, of the area F.

The limits of the paper forbid entering into an exact mathematical calculation respecting the draft of each construction, but the foregoing figure and explanations must convince you that my plan is superior in respect of draft, and we know that the less the draft the greater the velocity, other things being equal.

Now, in regard to "other things," they are *not* equal—the inequality being in my favor. For, with respect to the heads of my boat, I can model them in a manner superior to that of Burden's, for dividing and gliding over the water.

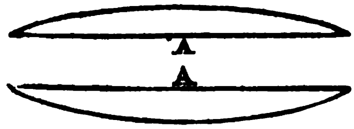
To perceive another advantage which my mode possesses over his, we will imagine that his deck is removed, and that we, being in the air over his boat, look down upon it. It will

of course present the following appearance—the twins being 16 feet apart at the centre C C.

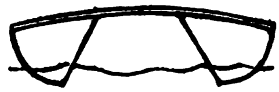


I am told that about $\frac{1}{16}$th of their length is above and clear of the water at each extremity. Therefore, supposing them to be in motion towards A, we at once perceive that a volume of water at B B, about 21 or 22 feet wide, (the distance between D and D being exact 24 feet,) must of necessity be compressed to a width of 16 feet in its passage at C C, and that the greater the power with which you urge the boat, the greater will be the accumulation of water at B B.

My boat viewed from above would present the following appearance:



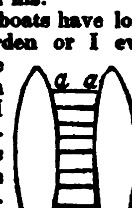
from which you can of course perceive that the water in its passage between the twins can meet with *no* obstruction. The two inner sides at A A can be either perpendicular to the surface or inclined toward each other, shown thus by end views:



In either mode the water passes without obstruction. For certain reasons it is thought that inclined inner sides, as in the under figure, are preferable.

My other advantages are, that I can use the holds of my twins, which Burden cannot do with his; and that I can construct a much stronger fabric, capable of withstanding a heavy sea, which cannot be said of his.

It is well known that twin boats have long been in use before Mr. Burden or I ever thought of our plans. The principal point of superiority in mine over all others is, that I dispense with those great obstacles to rapid motion, the *inside bows*, represented by *a a* in the annexed view of a common New-York ferry-boat.



They (the two inside bows) although as sharp as the two outside bows, it can be seen at a glance, impede a boat's progress vastly more than the two latter.

The keels of my twin boats being of a curvilinear shape, allow the boat every facility required in steering and turning. Respectfully,

Charles Harris.

P. S.—I will add that, with a rough model 5 feet long, the whole of which, with all her spars and sails, weighed not 10 pounds, having hoisted her sails on the river in a good sailing breeze, I could hardly catch her in a large boat, steered by myself, and propelled by a large sail and two stout oarsmen. She beat me when I used the sail only. If a little model would do this, what must be the velocity of a large vessel built upon this plan?

N. B.—The cuts intended to illustrate and explain the inventor's plans are so indifferently executed, that but an imperfect idea can be gained from them.

Lansingburgh, March 5, 1834.

To the Editor of the Mechanics' Magazine:

Sir,—I wish, through the medium of the Mechanics' Magazine, to offer a few remarks on a communication which appeared in the "Evening Star for the country," of February 28, signed by a Mr. Charles Harris, announcing his discovery of a plan of a boat which is to put Mr. Burden's boat at least into the back ground, if not into oblivion; of which wonderful discovery, Mr. H. has had the prudence to avail himself and heirs, by securing it at the patent office. I should not think proper to notice the above communication, were it not that there are persons possessing both the means and the disposition to patronize valuable improvements, but who have not sufficient acquaintance with mechanical science to enable them to judge with certainty as to the comparative merits of new inventions, until tested by experience. Such persons are liable to be imposed upon by plausible appearances, or to withhold that patronage from real merit which they would cheerfully give, if they knew where and when to bestow it.

With respect to Mr. H.'s plan of a boat, I have no disposition to question the sincerity of his belief, either as to the value of the discovery, or that he is the "*true and original inventor;*" but I wish to inform him, for his future benefit, and for the benefit of others, that he is as completely mistaken in one point as in the other; and he could not be more so in either.

With respect to his claim as the inventor, I would inform Mr. H. that Mr. Simon Fairman, now residing in this village, built a boat at Middletown, in Connecticut, in the year 1817, in the months of July and August, in all respects precisely on the plan which Mr. H. now claims as his. This boat, or model of a *steamboat*, was 35 feet long, and as Mr. H. very naturally describes it, was a boat split in two, lengthwise, through the middle, and the two approximate or inner sides were straight and parallel.

As it was not large enough, and indeed not intended for steam, he put in a wheel and prepared it to move by human power. It was exhibited at Middletown for some time, and he then, in the month of September, went down the river with it, and round to New-London, where it excited considerable notice.

The speed, however, was not equal to his

expectations. Upon strict examination, he found that the water in the straight passage being thrown back by the wheel, left a hollow towards the stern, which caused backwater. He then took out his wheel and built a false swell of considerable thickness on each of the two straight sides, and the result was a gain in speed, with the same power, from four to six miles per hour. After running it with passengers, a number of trips, between N. London and Norwich, he sold it for $300 to a gentleman who carried it to Demarara. So much for the originality of Mr. H.'s invention.

As to the superiority of strength his plan possesses over Mr. Burden's boat, the best way to decide the point is to make a strong iron bound barrel of good oak staves, and fill it with some heavy substance, say pork, for instance; and take the same kind of staves and make a square box to hold the same quantity, and bind it with the same weight of iron, and see which will endure the most violence without injury: or, what will amount to the same thing, prove that angles are stronger than arches.

In the advantage which Mr. H. calculates to gain over Mr. B.'s boat by the straight passage of the water through the centre and consequent removal of the angle of resistance in meeting the water, he will thereby add just as much to the angle, and of course to the resistance on the outsides.

I am not the advocate nor the eulogist of Mr. Burden. I am scarcely known to the gentleman, or he to me. But I should be sorry to see any gentleman deterred from encouraging Mr. B. and perhaps injuring himself thereby, and I should be equally sorry to see Mr. H. throw away his money, or that of any one else, under the mistaken idea that his plan is superior. He is certainly entitled to the satisfaction of trying the experiment, and I shall enjoy the satisfaction of having warned him of its inutility.

ARCHIMEDES.

Mr. Rutter's New Mode of Generating Heat—Successful Application to Gas Works. [From the London Mechanics' Magazine.]

SIR,—I beg you will not impute my long-continued silence to any other cause than incessant occupation during the last three months. I am not indifferent to the opinions of some of your correspondents, nor am I insensible to the kind wishes which have of late been expressed towards me, in reference to my process for generating heat.

To dislodge prejudice is no easy task, especially when it has become venerable by age, or respected through the influence of great names. Truth will eventually prevail; but its progress bears no analogy to that of the glowing meteor. May it not rather be compared to the twilight of the morning, that melts imperceptibly into the dawn of perfect day?

It was once the fashion, I believe, to devise ingenious theories, and then endeavor to make practice conform to those theories. This seems to have been beginning at the wrong end. A more natural process is now adopted,—a process in which experiment supplies the materials for constructing theories and illustrating first principles.

Arrears have accumulated so heavily upon me that I scarcely know where to commence. If I pass over any of the observations of your correspondents which appear justly entitled to notice, I hope you will believe the omissions are unintentional. Until Colonel Macerone (No. 529, page 453,) republished his letter of November 25, 1826, I was wholly unacquainted with his views respecting the use of liquid fuel. I do not remember that I had ever seen, or heard, or read, any thing relating to the subject until the summer of 1832, and then my information extended no further than that coal tar was employed in heating gas retorts.

Mr. Cheverton (No. 531, page 28,) first made me acquainted with the name of Morey, whose 'American water burner' was very kindly and opportunely described (No. 533, page 52,) by Mr. W. H. Weekes. That experiment was new to me. I have since tried it, but, I must confess, without any perception of its being rendered "applicable, in many cases, in place of a furnace."

Mr. Cheverton implies a doubt as to the possibility of decomposing water economically. He admits, however, that "our knowledge of light, heat, and combustion, is very obscure, and that experiment is our best guide in the absence of perfect theory." I fully agree with him.

Almost all that was formerly known about the conditions of decomposing water by heat, seems to have related to effecting it in close tubes or vessels, heated externally, the hydrogen being liberated through the agency of readily oxidizable surfaces. The conditions of my process are very different from those just mentioned.

That water is decomposed when employed in conjunction with certain carbonaceous fluids, may be doubted or denied. It is one thing to deny, another to disprove: seeing, with some persons, is not always co-existent with belief. But truth is unalterable, whatever differences of opinion may prevail respecting it. In physical science, fact and experiment constitute the only safe guides to theory. Theories may be constantly changing, or they may be altogether false: not so the laws which govern the elements of the material universe. We may be ignorant of those laws, but are they on that account the less uniform and invariable in their results?

Mr. George Bayley (No. 533, page 52,) has my thanks: were he to see my memoranda of last May and June, he would be amused at the coincidence of our views respecting the use of tanks for stowing tar and preserving the trim of vessels. Will Mr. Bayley permit me to set him right in a trifling matter? The specific gravity of coal tar is *greater* than that of water.

The communication of your Salisbury "correspondent" was almost a verbatim copy of my own printed statement. I have no intention of interposing between "Correspondent" and "An Old Gas-maker," neither of whom are known

to me, excepting in your pages; yet I may perhaps be permitted to say a few words to the latter, in reply to his remarks, No. 537, p. 125.

It never was intended to set forth that 17,100 cubic feet of gas could be obtained from a chaldron of Newcastle coal *only* through the agency of my heating process. It would be mere trifling to say that heat, externally applied to retorts, whatever may be the kind of fuel employed, could materially affect the internal process of distillation. All other conditions being the same, I produce an equal quantity of gas from a given quantity of coal, whether the fuel employed be coal, or coke, coal and coke combined, or coal in conjunction with fluid materials. I will not say that an equal amount of work may be done in the same time, and at the same cost with solid fuel, as with solid and liquid together. In the former case it is more difficult to preserve the same uniformity of temperature than in the latter; and it is impossible, by any ordinary means, to obtain an equal quantity (or intensity) of heat from equal weights of solid and of liquid fuel.

The most startling part of 'Correspondent's' (or rather my statement), in the view of 'An Old Gas-maker,' seems to be that which relates to the density of the gas. An increased quantity of gas, and at the same time "an increased specific gravity," is "so much at variance with the generally received opinions of the present day," that "An Old Gas-maker cannot but conclude that there must be some error in that part of the statement." I have great pleasure in assuring him that there is not the slighest error. During the week last past, I have made from 81 bushels of Newcastle coal (80 lbs. per bushel,) 40,590 cubic feet of purified gas = 18,036 feet per chaldron = 14,028 per ton. Average sp. gr. 0.535.

These workings may not be in accordance with "the received opinions of the old school." I cannot be answerable for that. Experiment, not opinion, has been my guide. I only exhibit facts as I find them. By experiment I would have it understood that I mean not a *mere* experiment, which may rather be viewed as an exception than adopted as a rule. The manipulations of the laboratory are very often at variance with those of the manufactory. All my experiments have been conducted in the ordinary course of practical workings, and the results have been verified in the course of successive days, and weeks, and months.

At a neighboring station my mode of working has been successfully adopted. Last March the maximum product per chaldron on that station was 13,000 feet. In October, from the same kind of coal, 16,500 feet were made.

It has been said that it is impossible to make 18,000 feet of gas from a chaldron of Newcastle coal, since it involves the absurdity of getting more out of the retorts than had been put into them. This is assertion without proof, and is as much deserving of credit as the received opinions, that quantity and increase of sp. gr. are always in a direct inverse ratio.

To comfort an Old Gas-maker, I can assure him that the retorts I am now heating, by means which he is pleased to designate 'a new combination of the fiery elements,' are in excellent condition—and the furnaces stand well. The same retorts did almost all the work of the station here, during the last winter.

I am not sure that I have yet attained to the maximum product of gas from a given quantity of coal. After making 18,000 feet per chaldron, I find there are sufficient materials to make probably 4 or 5,000 feet more gas. At present I have no means of appropriating these materials for gas-making economically. With the same retorts, and the same apparatus that I am now working, I required, in Nov. 1832, to produce 46,580 feet of gas, 136 bushels of coal. In Nov. 1833, I have made an equal quantity of gas from 92½ bushels of the same kind of coal.

A question in which every practical gas-maker should feel interested, is, whether it be best to keep up a large fire principally for the purpose of making tar and coke, and ammoniacal liquor, or whether that fire may not be more profitably employed in generating gas?

It would extend this paper beyond all reasonable limits, were I now to enter more fully upon details. It would, moreover, be anticipating the proposed publication, in a different form, of my views and experiments connected with this subject. 'An Old Gas-maker' will, I hope, exercise a little patience; and if I appear to him somewhat slow in my movements, let him remember that I am neither an *old* gas-maker, nor a gas-maker by *profession*. All I do in that, or any other department of science, is during the few interstices of leisure that occur amongst more important engagements.

Will Mr. E. Walker, No. 536, p. 107, be so good as to inform the readers of the Mechanics' Magazine, by what means he has ascertained that coal gas, when used in close apartments, is a *deadly poison*? Is it absolutely necessary, when this gas is so used, that it should be permitted to escape into the room? What are the properties of the respective products of combustion resulting from purified coal gas and *long ten* tallow candles?

That I am deeply interested in these questions, Mr. Walker will perceive, when I tell him that I use gas in my bedroom instead of rush candles. I have done it because gas is cheaper than candles, and much more convenient.

J. O. N. RUTTER.

Lymington, Nov. 27, 1833.

Mr. Rutter's New Mode of Generating Heat.

[From the London Mechanics' Magazine.]

SIR,—Mr. Rutter says, with truth, that his invention is never likely to be used where fuel is cheap, for according to his statement, although tar is but three-pence per gallon, it is still dearer than coal, the account standing thus:

4 cwt. 0 qr. 20 lbs. of coke at 25s. per ton,	5s. 2½d.
27½ gallons of tar at 3d....	6s. 10 d
	12s. 0½d.

And coal may be had at from 7s. to 12s. per ton.

Besides, as the demand for tar increases, so

must it increase in value, and thereby operate still further against its general adoption. Then, as regards originality, without wishing to detract one iota from the merit of Mr. Rutter, I think it but right to say that, at the gas-works here, tar has been consumed for some years past, not for the sake of economy, but merely to get rid of it, and, as I take it, in a manner somewhat analogous to that proposed by Mr. Rutter, viz.: over a certain measure of coke are thrown two cans of water, and one of tar; but from the effluvia arising from its combustion, this admixture cannot be used.

In commenting on the new mode of generating heat, Mr. G. Bayley, page 51, has been hurried, by an inconsiderate admiration, to wander far from the truth, and that, principally, through confounding weight for bulk. Want of "stowage" can only be understood to imply want of room, and a chaldron of coal and a chaldron of coke must occupy equal spaces; but as the former weighs 28, and the latter only 18 cwt., "stowage" cannot possibly be found in the same vessel for an equal weight of each. The comparison of volume and weight will therefore stand thus—

	cwt.	qr.	lbs.
A chaldron of coke	18	0	0
110 gallons of tar	10	3	6
	28	3	6

Which, multiplied by 3, will be equal to 86 cwt. 1 qr. 18 lbs. of coal.

Taking the specific gravity of coke and tar as equal, it gives 1·599 chaldron of the compound, and 3·084 chaldron of coals, or the effective quantities rather less than two to one, instead of three to one, as stated by Mr. Bayley.

As regards stowage, water of course need not be taken into account; but in estimating the comparative cost, 15 or 16 cwt. of water being required for every ton of coke, some allowance ought to be made on account of the labor, &c. necessary to remove it from alongside into the reservoir for supplying the fire. I will take leave of the subject at present, with noticing two minor errors: first, Mr. Bayley states the fluid required is withal of less specific gravity than water; while Mr. Rutter states the tar to be 11 lbs., and water is but 10 lbs. per gallon. Again, in stating the comparative economy, he says, 1½ gallons of tar at 1½d. per gallon, is a 1½d but this is no doubt a press error. Yours, respectfully, TREBOR VALENTINE.

Application of Mr. Rutter's New Mode of Generating Heat to Steam Vessels. [From the London Mechanics' Magazine.]

SIR,—My remarks, in No. 533, page 32, appear to have excited the displeasure of your talented correspondent, Trebor Valentine, on account of my "inconsiderate admiration" of Mr. Rutter's new method of generating heat, which, he says, had led me to wander far from the truth. This is a grave charge, and were it not made by a person in a mask, I might be induced to take it in high dudgeon.

How far I am justly liable to the charge of "inconsiderate admiration" of the process, is known only to myself. Not having a copy of my former letter at hand, I am unable to refer to the precise terms I then employed; but I have a distinct recollection that my "inconsiderate admiration" was chiefly referable to three points, viz., the saving of stowage, weight, and expense. It so happens that I have had some experience in building and navigating steam-vessels, and may, therefore, without presumption, lay claim to so much practical knowledge as to be qualified to express an opinion upon the desirableness of Mr. Rutter's method of generating heat.

I have often felt the want of convenient stowage for coals, notwithstanding there were many vacant spaces low down in the vessel, each containing a few cubic feet, in which small tanks for coal-tar might have been advantageously placed, but which were either unsuitable or inconvenient for the stowage of coal. The trifling weight of coke, compared with an equal bulk of coal, renders it much more convenient for stowage on board a steamer than coal, as it can be safely and advantageously stowed where it would be highly imprudent to stow coal, on account of its greater weight. Mr. Rutter's plan allows of the division of the fuel into small masses, so that, by due arrangement, it may be stowed in such a way as to lower the centre of gravity, and thus increase the stability of the vessel. Whether I have bestowed "inconsiderate admiration" on Mr. Rutter's plan, in this respect, I leave to you and your readers to decide.

With regard to the diminution of weight, I took Mr. Rutter's data, and, on reference to my former communication, think that it will be found that the difference is 3 to 1 in favor of Mr. Rutter's plan. Even on Trebor Valentine's own shewing, it is 2 to 1, which is sufficient advantage in point of weight to secure the "inconsiderate admiration" of persons like myself, who have found ourselves greatly impeded in our progress by the great weight of the coals we were compelled to take on board to supply the engines. But our "inconsiderate admiration" goes yet farther on this head, because the fluid admits of being stowed away in tanks, fitted to the vacant spaces near the bottom of the vessel, so as to bring the centre of gravity lower down than it usually is in steam-vessels worked with coals in the ordinary manner. This alteration in the centre of gravity would greatly increase the stability of a steamer, and lessen the labor of the captain and crew in trimming her upright when heeled either way, by the shifting of the passengers, or by the pressure of the sails. It is also very desirable to keep the vessel in as nearly the same trim as possible, that the paddle-wheels may act with their maximum effect. Mr. Rutter's plan offers the advantage of being able to dispense with half the weight we are now obliged to carry, and thus offers another attraction to call forth the "inconsiderate admiration" of the captains and engineers of steamboats.

It appears that I have made a blunder as to the specific gravity of the tar, and I stand corrected. I had no intention to misrepresent the fact, but having, as I thought, observed that

coal tar floated on salt water, I considered its specific gravity to be rather less.

I took the cost of the tar at 1½d. per gallon. I formerly purchased it at one penny per gallon, and not knowing its present price in large quantities, I thought that I had made sufficient allowance by stating it at three halfpence; and your correspondent, in No. 543, page 211, fully bears me out in my estimate being rather above than below the mark. Why Trebor Valentine should charge me with having wandered far from the truth, I cannot conceive, seeing that, for the purpose of convicting me of an error, he has at least doubled the cost of the ingredients in Mr. Rutter's plan for generating heat. Surely his "inconsiderate" prejudice, or something else, has led him far from the truth here, in order to decry a plan which, to say the least, is worthy of our approbation, for having suggested a method of applying to practical purposes a mode of generating heat which has hitherto been confined to the laboratory of the experimental chemist.

My calculation of the expense was made, as may be seen, upon the data furnished by Mr. Rutter, as to the quantities of fuel required to produce a certain effect. If he has erred in the proportions, my results are erroneous; but from the knowledge which I possessed of the cost of the articles, my impression was, and still is, that he had rather overrated the cost than otherwise.

If the cost of generating heat, upon Mr. Rutter's plan, should prove to be as great as by the present method, yet its saving of stowage and weight is sufficient to call forth the "inconsiderate admiration" of every one who has the charge of navigating a sea-going steamboat.

Trebor Valentine appears to have fallen into a very common error, viz. that if a certain weight must be carried on board a steam-vessel, it is of no consequence where it is put, whether on the deck or low down in the vessel's hold. Every nautical man knows that, with the same weight, a vessel may be either put into a good trim or be rendered utterly unseaworthy, according to the manner in which the weight is distributed, with regard to the centres of gravity and floatation.

It is a source of gratification to find that my views of the utility of the tanks for stowing tar coincide with those of Mr. Rutter; and I shall be glad to find that his plan is in actual operation on board some sea-going steamers; and I hope that you will not fail to give your readers the earliest information, with ample details of the results. To none will the information be more interesting than myself, for, although now unconnected with maritime affairs, I do not cease to feel a lively interest in every thing that relates to navigation and naval architecture. I am, yours, &c. GEORGE BAYLEY.

STEAM ENGINES.—The French Academy of Sciences have awarded a gold medal to M. Galy Cazalah, a professor in the Royal College at Versailles, for a discovery which, it is said, will give perfect security against the bursting of steam engine boilers.

INFLUENCE OF COLOR ON THE ABSORPTION OF HEAT AND OF ODOROUS PRINCIPLES.—On the 20th of June, 1833, a paper was read before the Royal Society, "On the Influence of Color on Heat and Odors," by James Stark, M. D., of Edinburgh; of which the following is an abstract.

The author observes, that the only experiments on record relating to the modifying effect of different colors on the absorption of heat from solar light are those of Franklin and Sir H. Davy. In order to investigate this subject, the author employed pieces of wool, silk, and cotton, which were wrapped round the bulb of a thermometer placed in a glass tube; the tube was then plunged into boiling water, and the time which elapsed during the rise of the thermometer from one given point to another was accurately noted. Other experiments were also made with an air-thermometer, of which the bulb was coated with various colored materials, and heat thrown on the ball by means of polished tin reflectors from an Argand burner. The results accord very nearly with those of Franklin and of Davy; the absorbing power with regard to different colors being nearly uniformly in the order of black, brown, green, red, yellow, and white. The author next investigates the differences which occur in the radiation of heat by differently colored substances; a subject on which he is not aware that any experiments have ever been made previously to his own. The mode of ascertaining the amount of radiation was generally the converse of that by which the absorption of heat had been determined: namely, by exposing the colored substances, in contact with a thermometer, to cooling instead of heating processes. The general result of all his experiments was, that the loss of caloric by radiation follows exactly the same order, with regard to the color of the radiating surface, as its absorption. In the second part of his paper the author gives an account of a course of experiments which he made with a view to discover the influence of color on the absorption of odorous effluvia, and more especially in the case of the absorption of the fumes of camphor and assafœtida by woollen cloth of different colors. Black cloth was always found to be possessed of the greatest absorbing powers, and white of the least; red cloth being intermediate between them. Cottons and silks gave, on trial, precisely the same results, which were further confirmed by the different weights acquired by these substances from the deposition of camphor upon them.—[Proceedings of the Royal Society.]

MIGRATION OF FISHES AND BIRDS.—"I fear I am not entomologist enough to follow the life of the May-fly, but I shall willingly have my attention directed to its habits. Indeed, I have often regretted that sportsmen were not fonder of zoology; they have so many opportunities, which other persons do not possess, of illustrating the origin and qualities of some of the most curious forms of animated nature; the causes and character of the migrations of ani-

mals; their relations to each other, and their place and order in the general scheme of the universe. It has always appeared to me, that the two great sources of change of place of animals was the providing of food for themselves, and resting-places and food for their young. The great supposed migrations of herrings from the poles to the temperate zone have appeared to me to be only the approach of successive shoals from deep to shallow water, for the purpose of spawning. The migrations of salmon and trout are evidently for the purpose of depositing their ova, or of finding food after they have spawned. Swallows and bee-eaters decidedly pursue flies over half a continent; the scolopax or snipe tribe, in like manner, search for worms and larvæ,—flying from those countries where either frost or dryness prevents them from boring,—making generally small flights at a time, and resting on their travels where they find food. And a journey from England to Africa is no more for an animal that can fly, with the wind, one hundred miles in an hour, than a journey for a Londoner to his seat in a distant province. And the migrations of smaller fishes or birds always occasion the migration of larger ones, that prey on them. Thus, the seal follows the salmon, in summer, to the mouths of rivers; the hake follows the herring and pilchard; hawks are seen in great quantities, in the month of May, coming into the east of Europe, after quails and landrails; and locusts are followed by numerous birds, that, fortunately for the agriculturist, make them their prey."—[Sir H. Davy's Salmonia.]

Opposition of Ignorance to the Use of Printing.—In the 'Typographical Antiquities' of Ames and Herbert, it is stated that the first book printed on paper manufactured in England came out in 1495 or 1496, from the press of Winkin de Worde. Shakspeare—whose chronology is not to be trusted—makes Jack Cade, in the reign of Henry VI., (who was deposed in 1461,) thus accuse Lord Sands: "Whereas, before, our forefathers had no other books but the *score* and the *tally*, thou hast caused printing to be used, and, contrary to the king, his crown, and dignity, thou hast built a paper-mill." The insurrection of Jack Cade was ostensibly for the redress of grievances amongst the people. Shakspeare fixes the complaint of Cade against printing and paper-making some ten or twenty years earlier than the introduction of printing amongst us; but he could not have better pointed out the ignorance of popular violence,—and all violence is the result of ignorance. The best instruments for producing good government, and equal laws for all men, have been the paper-mill and the printing press; and exactly in proportion as the knowledge which they embody has been diffused, have we advanced, not only in our social arrangements, but in every other manifestation of a prosperous and well ordered community. Whatever remains to be accomplished will go hand-in-hand with the continued diffusion of knowledge.

Removal of a Steeple.—The Genoa Gazette contains an account of the removal of a church steeple entire, at Crescentino, in Piedmont, from one point to another, at several yards distance, where it was placed on a new foundation. The master mason was so confident of success that he made his son remain in the steeple ringing the bell during the operation.

Gas in the Railway Carriages.—We understand that measures are in progress for the introduction of portable gas for the lighting of the railway carriages. One carriage has been already furnished with this illuminating principle.—[Manchester Advertiser.]

Sir John Herschell has sailed on his astronomical mission to the Cape of Good Hope. He is expected to be absent about three years. He went out in the Catherine Stuart private ship, which has also on board Major-General Sir B. D'Urban and staff.

Observations on the Prevailing Currents of the Ocean and their Causes. [From the United Service Journal.]

There are few branches of science, connected with the phenomena of the surface of the globe, which have hitherto received less consideration than those oceanic currents which every-where prevail more or less in the great body of the waters; and it seems surprising, that in a country situated like our own, and so intimately connected with the element which forms our rampart, as well as the great medium of our wealth and greatness, so little has yet been done to trace this continued circulation to its true and proper source.

Much expectation on this subject was lately excited by the announcement of Major Rennell's work "On the Currents of the Atlantic;" and it was but natural to expect, from the pen of so able and experienced a writer, some elucidation of this hitherto obscure subject. The expectations entertained as to this posthumous work have in many practical points been fully answered; the *existence* and *effects* of many important currents have been explained in a manner that cannot fail to be highly useful to every practical man. But in tracing the *cause* of this mysterious movement, Major Rennell seems merely to have followed the usual track that had before been taken by all former writers on the subject, and has thus been led to attribute *to the winds*, effects which owe their real origin to the main cause of these very winds themselves.

It has long been known, that the prevailing currents, both in the air and in the waters, have a regular set within the tropics,

from east to west; and as atmospheric currents in these latitudes, under the name of the *Trade Winds*, have been justly attributed to the rotatory motion of the earth on its axis, it has been incautiously adopted as a principle, that the currents of the ocean arise from the action of the prevailing currents of wind, both in the tropics and in other parts of the earth.

"The winds," says Major Rennell, "are, with very few exceptions, to be regarded as the prime movers of the currents of the ocean; and of this agency, the trade winds and monsoons have by far the greatest share, not only in operating on the larger half of the whole extent of the circumambient ocean, but by possessing greater power, by their constancy and elevation, to generate and perpetuate currents; and although the monsoons change half yearly, yet the interval during which they continue to blow in each direction is long enough to produce effects *nearly similar to the constant trade winds*;" that is, although the winds do not always blow from east to west, but are, during one half of the year, *north-easterly*, and for the other half, *south-easterly*, yet the currents in the open ocean, within the tropics, are *constant*, from east to west, *and thus do not follow the direction of the winds from which they originate*. "The winds, then," concludes Major Rennell, "operating incessantly on the *surface* of the ocean, cause, in the first instance, a gentle but general motion *to leeward*, (as is proved by ships being always to leeward of their reckoning in the trade winds;) and the waters so put in motion form by accumulation streams of currents."—[Rennell on the Currents of the Atlantic, p. 6.]

Setting out, then, upon this principle, in his account of the existing currents of the ocean, as far as they are at present known, it cannot excite surprise, especially if this theory of the origin of the currents can be proved to be erroneous, if many facts are stated in the work of Major Rennell which are utterly at variance with the theory itself; and the consequence naturally is, that, however distinct and instructive the information may be with respect to the individual currents, and the best mode of combatting their influence, we rise from the perusal of the work more than ever uncertain as to the true cause of those remarkable streams which are known, in numerous instances, to run in the very face of the steady and prevailing winds which are here stated to be the occasion of them.

In these observations upon Major Rennell's work, we must not be understood, however, as detracting in any way from the highly useful tendency of it in a practical point of view, for which it was chiefly intended; but we beg to offer a few remarks as an attempt to elucidate this obscure but interesting subject, which, like other questions relating to an extended system, must first be viewed on a great and general scale, before we can safely venture to account for the minor portions of it, which come within our more immediate and personal observation.

It appears strange, that while the aerial currents of the atmospheric fluids within the tropics have been so long attributed to their proper cause, it should never have occurred that *the same cause* might probably have *the same effect* upon the aqueous fluids which cover so large a portion of the globe, and that the currents of the ocean might thus be mainly attributed, like the trade winds, to the rotatory motion of the earth upon its axis. The more powerful and constant of the currents of the tropics having a general tendency from east to west, might be supposed likely to suggest this idea. But if suggested, and put to the proof by actual observation *on a limited scale*, it is probable that the theory would be rejected as inconsistent with the facts, for while the trade winds are found to be in a great degree constant, like the cause which produces them, and only varying a few points to the north or south, according to the season, and the position of the earth with regard to the sun, the streams of the ocean are found to set in various directions, and frequently in *opposition* to the supposed cause; we could not, therefore, feel surprised if some other cause was immediately sought for.

In order, however, to set this point in a proper light, we have only to examine with attention the effects produced by a rapid and rocky descent on the small scale of a river or brook. We here find the general tendency of the stream taking, *as a whole*, a decided course, (say from east to west;) but if we confine our view to the minor parts of this stream, and watch the movements of any small floating substance, as it follows the various eddies and countercurrents occasioned by the rocky impediments in the bed of the river, we shall with difficulty bring ourselves to believe that the general tendency of the whole stream is from east to west, as we frequently find the floating bodies taking a direction from *west to east*, and, at some particular points, even from north to south. This is taking a limited view of what ought to be considered on a wider scale, and may serve as an illustration of what actually takes place when we form a theory for the

whole currents of the ocean, by merely observing some particular portions of it.

What takes place in a fluid on a small scale will assuredly occur also on a larger, as both are subjected to the same general laws; and because the trade winds are not so subject to opposition, and consequently to eddies and counter-currents, as the equatorial streams of the ocean, we are not, therefore, to conclude that both fluids are not originally set in motion by the very same cause, for it is obvious that, though their general tendency may be (as indeed it really is) *from east to west*, the numerous interruptions opposed to a regular movement in that exact direction may often occasion an extensive re-action in a direction to all appearance opposite to it.

Let us for a moment suppose the earth to be a body *at rest*, or at least without rotation on an axis; and let us further suppose no dry lands to exist above the surface of the waters, with which latter the sphere would thus be entirely covered. Let us also in idea remove its atmospheric envelope, that all friction or pressure may be removed between the two fluids of air and water: what, then, could we expect to find under such an arrangement? We could not look for any circulation in the watery covering, under such circumstances. Every thing would remain in perfect repose; and unless the waters were preserved in purity by some principle not now in existence, they would soon become corrupted and unsuitable to the nourishment of organic life. But let us now suppose a sudden impulse of rotation to be given to the sphere with its fluid covering; and let us consider what would be the effect of the rapid rotatory movement upon the circumambient waters. If a plate or other shallow vessel containing water be impelled in any direction horizontally, the fluid, participating but little in the impulse, *is left behind* on the spot whence the movement began; it cannot keep pace with the motion of the solid. In the same manner the globe would revolve upon its axis, while the superficial waters would remain nearly stationary, and would have all the appearance of moving in opposite directions, *seeming* to transport floating bodies from east to west, while, in point of fact, the earth *was passing them* from west to east. Thus we perceive that, in the supposed case which we have now put, the steady movement of the solid ball would be imperceptible, while floating bodies on the surface of the water would visibly become more distant in an opposite direction. This apparent movement would naturally be greatest in the equatorial regions, being the outer rim of the revolving wheel; while towards the axis the waters would be little, if at all, affected by the rotation.

Let us now, for a moment, suppose our globe to be surrounded with its atmosphere, or envelope of fluids of a different nature. Without rotatory movement in the solid, there could be no semblance of regular movement in this aerial fluid, and we could therefore have no trade winds. Other partial winds there would be, it is true, occasioned by heat acting on the elasticity of the air, and by a constant succession of expansion and contraction arising from various degrees of temperature. But if we suppose, as before, a revolving and rapid motion to be given to the sphere thus surrounded with its airy envelope, a similarity of cause would immediately occasion a similarity of effect. The *trade winds* would be produced in the equatorial regions, while the circulation of the atmosphere in the more temperate and frigid latitudes would be carried on by the changes of temperature in the same manner, or nearly so, as if there had been no rotatory motion at all.

The effect of the trade winds, and, by analogy, of the oceanic currents, may be simply illustrated by the example of a well-mounted horseman in a calm day. While he remains still, not a breath of air blows. He moves slowly, but produces little effect in deranging the quiet of the atmosphere. The more rapid his course, however, the more violent will be *the current of air* which *seems to* blow in his face whichever way he goes; and even in the case of a moderate breeze, he may "outstrip the wind," and make it seem to blow in an opposite direction.

It must be obvious, then, that the effects of the revolving motion of our globe must be the same, both upon *the fluids of the air*, and upon *the fluids of the ocean*, and consequently, that the regular *trade winds*, and the regular *equatorial currents*, proceed each separately from this cause, and would equally exist even in the absence of the other. But it may be urged, that the trade-winds are much more constant to their course than the equatorial currents, and it therefore seems difficult to imagine that they can both proceed from the same cause. The reply to this objection is extremely simple, when we look a little deeper into the nature and circumstances of the two fluids. The atmospheric fluid is above the surface of the solid, and is but slightly deranged by the asperities and interruptions it may have to encounter, in the form of the islands, continents, or mountains of the earth. Some derangement actually does take place, however, from these

causes, but it bears no comparison to the counter-currents and eddies which are found in the ocean, arising from the numerous and insurmountable obstacles which are thrown in the way of the regular equatorial streams. In the supposed case, which was before put merely for illustration, we considered the globe to be entirely covered with the waters. Such is not, however, the reality now, although this preternatural effect has certainly existed, on one most memorable occasion, the evident traces of which attest the fact on every part of the surface of the globe. Such is not, however, the usual state of things; on the contrary, the ocean occupies about two-thirds of the whole surface, while the remainder is broken into a thousand dispersed fragments, each opposing its solid form, as the sphere revolves, to the regularity of the oceanic movements. If the smooth and polished wheel of the turner be made to revolve in water, the movement, however rapid, produces little or no commotion in the fluid; but let the polished wheel be changed for one having a toothed or unequal edge, and we shall instantly perceive a very opposite effect. The effects of the paddles of the steamboat on smooth and tranquil waters will also bring this subject home to the mind of every one. We cannot then look for the same regularity of movement in the equatorial currents of the ocean that is perceptible in the equatorial currents of the atmosphere.

In considering the origin of the currents of the ocean, it must be kept in mind that they proceed from two distinct causes, and thus exhibit one of the most wonderful and provident effects to be seen in the order of the works of the Creator. Water and air, if left stagnant, soon become corrupt and unwholesome; and it is evidently a wise provision of the Almighty, which has furnished the laws by which a constant circulation and movement are kept up in both. In the case of the atmosphere, the circulation occasioned by the *winds* takes place, partly by means of the revolutions of the earth on its axis, and partly by the expansive nature of air when affected by the heat of the sun. The lower beds of the atmosphere are elevated into the higher regions by heat; and other portions of the fluid, rushing in to fill up the vacuum, occasion streams of wind of various degrees of force. The seasons of the year, and the duration of the effects of summer and winter in various latitudes, also occasion similar currents of air more or less durable, according to circumstances. But in the case of the currents of the ocean, there are but two causes from which constant currents can primarily arise: one from the rotatory motion of the earth, from *west to east*, which causes an *apparent* current from *east to west* in the open seas near the equator; the other cause arises from the inclined position of the earth with regard to the sun, by which a greater *evaporation* takes place from the waters of the sea within the tropics, than in the more temperate and frigid zones; and on the other hand, a proportioned *condensation* of this vapor (in the form of rain, dew, and snow,) takes place in the latter regions, greatly superior in quantity to what falls, during the whole year, in the former. These effects of temperature are so vast, when viewed upon the scale of the whole earth, that the balance of the ocean would be deranged by them, thus *losing* water in one region and *regaining* it in two others. This want of equilibrium is, however, obviated by constant currents in the ocean, from the poles towards the tropics.* In figure 1 of the following plate, (where the outer line denotes a supposed boundary to the atmosphere,) we see the vapors rising from the equatorial regions, and passing towards the poles, where they return to their parent deep, in the form of dew, rain, and snow. Thus restored to the ocean, they flow towards the tropics, and there chime in with the prevailing currents, in their course to the westward. In the central part of the same figure an idea may be formed of the effect of an intervening continent, in opposing its solid form to the fluids through which it is rapidly and constantly passing, with greater velocity than those fluids can possibly follow it. At 1, the equatorial current meets an opposing cape, which divides it into two parts: one flows pretty freely from the north-west, being kept, however, in its place by the north polar currents pressing towards it. It meets another projection at 7, still farther to the north; and after passing it, the stream is *forced* into its more natural position near the equator, and proceeds in its westerly course, after forming a great counter-current or eddy in the sheltered gulf at 6, where navigators would fall in, for days toge-

* It is probable, perhaps even certain, that *heat* has also a very considerable influence in keeping up the movement and circulation of the waters, but it is not likely that currents of great extent are set in motion by this cause. Water, like air, expands by heat, and contracts by a certain degree of cold, not, however, so low as the freezing point, for at that temperature ice is formed, and the formation of ice is always accompanied by violent expansion, so great, indeed, as to burst the strongest vessels, and to cause explosions like cannon, in the lofty glaciers of Alpine regions.

As warm water rises above the colder, (except in the extreme case of ice, which always floats,) and as currents and counter-currents are always acting *horizontally*, and then intermixing the fluids from the poles and from the tropics, it is obvious that an interchange must also be constantly going on *vertically*, in the waters of the ocean, and then completing the circulation of which the great superficial currents, already described, are the leading cause.

ther, with what would appear, if viewed on a small scale, totally opposed to the theory now under explanation. Returning to the Cape at 1, we find the other half of the northern equatorial stream proceeding to the south-west, where it fills the deep gulf, or sea, at 3, and keeps up the waters there at a high level, on a principle which will immediately be explained. It cannot, however, make its escape in a body or current from this gulf, but, being confined by the southern division of the equatorial stream, a variety of eddies on a considerable scale are produced at 2. It is unnecessary to explain the figure further, by proceeding to the southern hemisphere, where similar effects are produced by nearly similar causes at the points 4 and 5; we may therefore proceed to explain upon what principle the level of the sea in the gulf at 3 is kept up at a higher level than the same surface in the bay at 6, an effect which is known to exist in several remarkable instances on the globe, and which, according to the theory, ought to exist in every situation similarly situated.

By fair analogy, we find that, in this, as in other parts of nature, what takes place on a small scale may also be looked for on a larger. Proceeding then upon this principle, and considering minutely the rapid and rocky course of a brook or river, we find that, so long as the water flows over a smooth and equal bed, the depth and surface of the stream are in all places alike, as in figure 2 of the plate. But when, on the other hand, a fixed and solid opposition is encountered, in the form of a projecting rock, derangement in the level instantly takes place, to a degree proportioned to the bulk of the opposing object. An accumulation or rise in the water takes place on the upper side, until the current finds a vent at one or both extremities, and without this vent, the accumulation increases until the water flows over the top, when the difference of level above and below the object is at once apparent (see fig. 3). But supposing the impediment to be small, in proportion to the size of the stream, still, in every case, a change of level must be the consequence; and the recovery of tranquillity is only completed at some distance below the object, where it, at length, falls again into the general inclination. Beneath or behind this opposing rock, then, there is a sheltered nook, upon which the stream can only act in the form of an eddy; and in such nooks buoyant objects are often kept, as it were, imprisoned by the force of the stream on each side, and floating round in one continual circle. These eddies of the smaller rivers are equally well known to fish and fishers, as both are there sure to find their wished-for prey. Now, all these effects are to be expected on the great scale of the ocean current, as well as in the smaller instance of an inland brook. The *streamward* side of these mighty rivers will always be found on a higher level than the *eddy side;* and consequently the inland gulf at 3, (fig. 1,) ought to be considerably higher than the waters in the bay at 6, which remains sheltered from the powerful action of the current. Thus the level of the Red Sea, which is filled and kept up by the action of a powerful stream across the Indian Ocean, was found, by the French engineers, to be so considerably higher than that of the Mediterranean, that much difficulty and expense would have been incurred in the canal which was once projected across the isthmus of Suez, in order to facilitate the communication with India by this route. A second instance of this effect no doubt exists in the gulf of Mexico, compared with the level of the north Pacific on the western coast of Mexico; but the actual difference of level has not yet been ascertained. A remarkable instance, however, of this difference of level, obviously arising also from the above cause, has been kindly communicated to us by Sir H. Douglas, who was then governor of New Brunswick, where it was found that, in a proposed canal intended to have been cut from the top of the Bay of Fundy to Bay Verte, in the Gulf of St. Lawrence, (a distance by land of only fourteen miles,) the difference of level of the two seas was no less than sixty-three feet,* the rise of the tide in Bay Verte being only seven feet, while that in Cumberland Bay, of the Bay of Fundy, exposed to the full force of the Gulf stream, was seventy feet. The Bay of Fundy is kept at this high level in consequence of the projecting peninsula of Nova Scotia impeding the current which rushes along that coast towards the north, and which, from the bend of the coast towards the north-east, is carried in that direction, leaving the gulf of St. Lawrence as a sheltered eddy or nook.

We may now proceed to a cursory view of the whole existing system of the currents, as far as the observations of navigators have made us acquainted with them; but in the rapid sketch which is alone consistent with the limits of a paper of this description, it would be impossible, and even injudicious, to be led from the general outline into any notice of the innumerable minor currents of which seamen have frequently made men-

* Surveyed by Mr. Francis Hall, and reported upon by Mr. Telford.

Fig. 1.
Theory of the General System of the Currents both of aqueous and aerial Fluids.

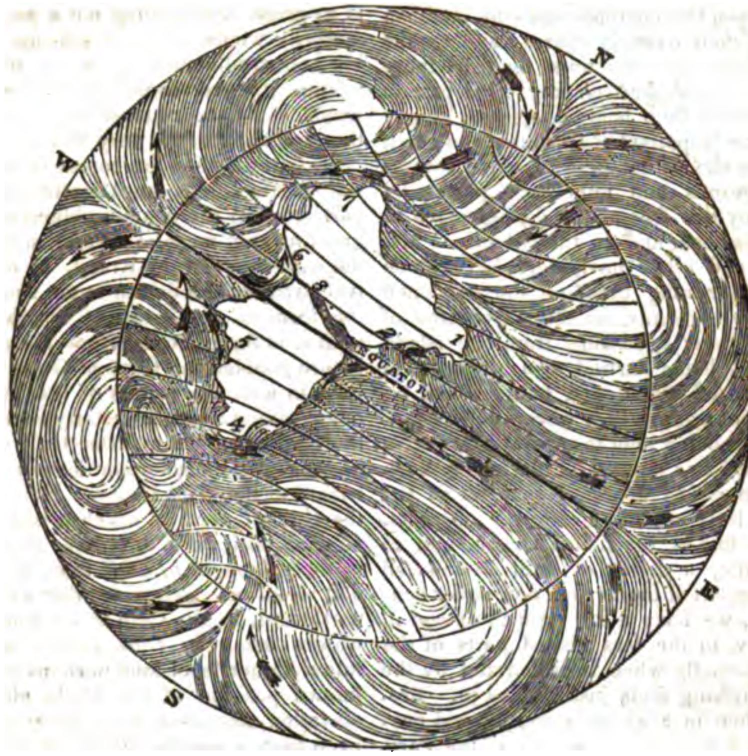


Fig. 2.
Unopposed Current.

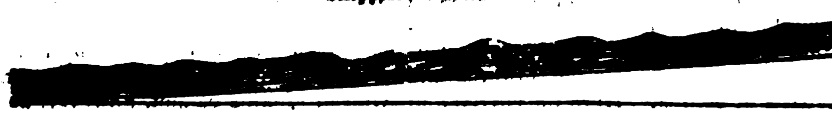
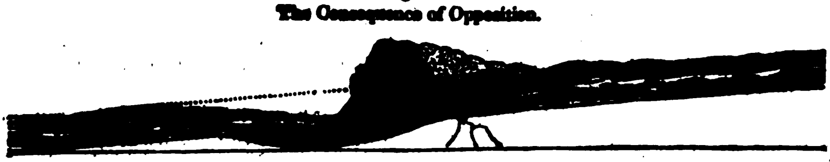


Fig. 3.
The Consequence of Opposition.



tion, and which may often be looked upon as eddies and counter-currents, produced by the main body of the stream,* and being occasioned by a variety of changing circumstances, may not again be found in the same exact position.

As it is necessary in this circuitous course to start from some particular point, which may be considered as it were a commencement of the circle, we may adopt as the most proper the western line of the continent of America, whereby the circle is more nearly broken, from pole to pole, than by any other of the dry lands of the earth. Setting out then from this point, and viewing more especially the equatorial line of currents, we

* Major Rennell's work on the currents is accompanied by a laborious and valuable volume of charts, which, if any objection could be made to them, might be considered so minute as to produce confusion. It appears that the courses of the minor eddies have been laid down wherever any naval authority could be produced for their existence, although it is more than probable that a large proportion of them may not again be found in the same position by future navigators.

enter the immense expanse of the North and South Pacific, where every account that has touched upon the currents tends to establish the fact of their westerly course; and as the force of these currents must there be more steady and equal than on any other part of the globe, from their being unopposed by any thing more important than clusters of small islands, we should not expect them to assume that dangerous and impetuous power by which they are frequently distinguished in the Chinese sea, and in the Atlantic. Mr. Mariner, and other navigators, have given us some interesting proofs of the existence of westerly currents, in the adventures of parties of natives, passing from one island to another, being carried to a distance of many hundred miles, and being found on islands from whence they were utterly hopeless of ever being able to regain their native shores. Of this portion of the globe, however, it must be admitted that we as yet know but little with regard to the currents. But if we find in the Indian Ocean, and in the Atlantic, a series of well established facts in support of the system now under consideration, we have a full right to extend it, by analogy, to the less visited parts of the globe, especially when corroborated by the few but striking facts just alluded to. Proceeding then in a westerly course, and having reached the western bounds of the Pacific, with the Chinese islands and shores on the one hand, and the continent of New-Holland on the other, we hear of a succession of powerful currents from the eastward, forcing their devious courses through the crowded archipelago, and pointing towards the east coasts of Africa. Here the currents of both sides of the equator, being confined in a much smaller space than in the Pacific, and being forced by the form of the land out of that position which is naturally given them by the rotatory motion of the earth, become more violent, and consequently more obvious. In their efforts to retain their position north of the equator, they act with great force against the shores of the seas of Bengal and of Arabia, occasioning in the former the well known and formidable surf of Madras. Finding no vent in a northerly direction, the united stream is forced to the southward, along the east coast of Africa, and if left at liberty, it would follow the southerly impetus thus given to it, and flow into the southern ocean. In this, however, it is opposed by the south polar currents, and it therefore no sooner arrives at the Cape of Good Hope than it doubles that point, in the well-known Lagullas stream, and, running in a north-westerly direction, hastens to regain its natural position on each side of the equator. The force of this current off the Cape is so great, that nothing but a prevalence of westerly winds at some seasons could enable outward-bound ships to make head against it; and even with these favorable winds, ships are constantly found driven to the westward in the very face of the wind.

In following out the course of the equatorial stream across the Atlantic, we find it in part crossing the equator obliquely, and this great moving mass of waters, striking upon the eastern point of Brazil, is divided into two streams, one driven to the southward by the form of the coast of South America, until it is forced round Cape Horn, as it had before doubled the Cape of Good Hope, and joins in with the waters of the Pacific; the other, taking a north-westerly course towards the Caribbean sea and the Gulf of Mexico, passing with considerable force amongst the islands of the West Indies. Having reached the Gulf of Mexico, which opens its extended arms, as it were, to receive it, the current is there brought to a full stop, being precluded from advancing to the westward, or northward, by the form of the lands, and the waters being in consequence *accumulated* into a higher level than perhaps in any other known position of the whole globe. This elevation has often been *supposed*, and has even been shown to be demonstrably certain, without, however, any good reason having even been assigned for the phenomenon. We here, therefore, find a natural, and even necessary cause, upon the same principle as has been already explained by fig. 3 of the plate. The high level of the sea in the Gulf of Mexico cannot, however, pass a certain boundary, and the swell of waters at length finds relief by the only possible, though tortuous course, that is left open for its issue. The stream then rushes with a violence proportioned to its late confinement, round the south point of East Florida, and here, taking the name of the Gulf Stream, it proceeds to the northward, along the coasts of the United States to Newfoundland, where it encounters the Great Bank, and becomes again divided, one portion continuing towards the north and east by Iceland and the coast of Greenland, until again stopped by the north polar currents; and the other, bending to the east and south, is terminated in an immense vortex in the centre of the north Atlantic, where it accumulates on the surface prodigious quantities of the *fucus natans*, or Gulf-weed, which is known to flourish in the warm waters of the Gulf, and to be carried by the stream into the Atlantic, and there covers the surface for hundreds of

miles, together with floating timber and other bodies, washed out by the rivers of America. In this great eddy, then, the famous Gulf Stream may be said to terminate; but not so the other portion of the current which had passed on towards the north: when met by the north polar currents from the arctic seas, it is headed back towards the south, along the coast of Norway, and into the North Sea. We here feel its effects upon our own coasts, especially of the north of Scotland, and of Ireland, where floating substances from southern latitudes are frequently found. A minor branch passes through our channel, and rejoins the greater stream across the Bay of Biscay; and the whole at length becomes blended once more in the equatorial current off Cape Verde and the coast of Africa.

In an interesting work which has recently appeared—the Narrative of Capt. Owen's Voyages for the Survey of the Coasts of Africa—we have a distinct proof of the great obscurity which still overshadows the subject of the currents. In the observations on the results which have been gained by this long, interesting, and most fatal expedition, we find the greater part of the subject connected with the currents summed up in the following passages at the end of the work.

"As in the foregoing narrative but few observations have been introduced respecting the currents, and as it is a subject of much speculation and interest, at least to those connected with navigation, the following remarks from Capt. Owen's Journal may be considered worthy of publicity.

"It is a well known fact, as regards the African seas, *that there is a perennial current which sets into the Atlantic Ocean*, round the entire southern extreme of that continent; this current varies in its velocity in different situations, and at different periods, from five miles to one mile an hour. Some writers have supposed that, with reference to the Great Ocean, the Atlantic may be considered as a kind of mediterranean sea, the evaporation from which, together with winter frosts to the northward, must be supplied from the Southern Ocean, in like manner as the Mediterranean is fed from the Atlantic; *and this hypothesis is borne out* by the strong perennial currents about the shores of Cape Horn, and through the islands in its vicinity. But it is remarkable that these currents never appear to extend more than *twenty leagues beyond the common deep-sea soundings*, while their velocity is much decreased when near the shore; from which it may be understood that the depth is much diminished, and the stream broken by projections of bank and sand.

"Ships are frequently carried to the westward, quite round the Cape of Good Hope, *even against the strongest north-west gales*, by this current."

Capt. Owen then proceeds to state the dangerous nature of the short though *high* waves produced by the currents and wind being in opposition, and the most effectual course by which the danger may be avoided. It is quite clear that every thing here stated is strictly in accordance with the theory here advanced. He bears witness to the *constancy* of the current from east to west; and in other parts of his work, when treating of the east coasts of Africa, and those of Madagascar, he mentions the rapid nature of the currents *passing down from the northward towards the Cape*, by which, in one instance, the Levén, in making the point of Mombas, was driven so far to the southward, that it took her *six days* to regain what she had lost by the failure of the wind for about *three hours*.—[Vol. II. p. 150.]

It is known also that, off the Cape, ships have been driven to the westward, at the rate of sixty or seventy miles per day, *even against* a strong westerly wind.

The only part of Capt. Owen's statement which in any degree stands opposed to what is now advanced, is the allusion to the constant currents at Cape Horn. These are not *stated* to run to the eastward, or *into*, instead of *out of* the Atlantic, but that fact is implied by the theory of *evaporation* from the Atlantic, which is counter-balanced by *entering* currents at both capes. This is opposed by the general reports of the navigation of Cape Horn; it is opposed also, most distinctly, by the much better attested facts of currents *out of* the South Atlantic towards the north. For if evaporation took place on so great a scale as to produce *entering* currents at the two great capes, we must admit that an *entering* current should also flow from the colder latitudes of the north, which is not the case. As to the fact of the current at the Cape being little felt *close in shore*, and gradually diminishing in force as it extends to the open ocean, a hundred miles or more from land, it is in every way consistent with the whole theory of inland rivers. In the case of a projecting bank or rock in a river, the actual point of contact is exposed to great violence, but every other point of the stream exhibits the phenomena described by Capt. Owen off the Cape. Under the most projecting rock or point, comparatively smooth water is generally found close to the side; while the main

body of the stream drives past with a distinct and rippling outline, diminishing in force, however, as it spreads out into the expanding pool below.*

We have thus passed in review the great and leading course of this wonderful and most admirable system by which the waters of the ocean are kept in that continued movement so necessary to their purity, and by which, also, it is highly probable that many important ends are effected, in regard to the amelioration of the climates of various parts of the earth. The land and sea breezes of the hotter climates are now well known, and also their causes. We may naturally suppose this wholesome interchange to be powerfully affected by streams of current from the cooler latitudes; and we also may be assured that the heated waters of the Gulf Stream must carry along with them into the Frozen Ocean a degree of warmth which cannot but materially affect the rigidity of those latitudes. Even in our own country, we are well aware, from continued experience, of the mild effects of a westerly wind. We have no particular warmth to look for from the *lands* to the westward of us; on the contrary, the winters of Labrador and of Canada are well known to be unusually severe. But when we find that a vast reservoir of heated water, and consequently of *warm vapors*, exists in the Atlantic, we can no longer find a difficulty in naturally accounting for the mild and humid effects of our westerly winds, which, even in winter, produce on Ireland and the west coast of Britain the verdant growth of a milder season.

It is scarcely necessary, in conclusion, again to revert to the theory of the winds being the prime movers of the currents; for besides the arguments already adduced, by which we trust it has been shown that ocean currents could not but exist, even if there were no winds whatever, we have only to examine the numerous instances mentioned even by Major Rennell, of ships being drifted far to *windward*, in the very teeth, not of transient breezes alone, but of settled and heavy gales. "One ship," says he, "was carried 10° of longitude (*equal to 570 miles*) to the westward, between Cape Verde and the Cape of Good Hope, and yet had been subjected to the south-east trade wind. Another was driven 220 miles, between the Canaries and the coast of Brazil. Another in the equatorial current, in June and July, was set 297 miles to the westward, *in five following days*, between 3° north and 4½° south, and yet had entered the south-east trade wind." Such, and numerous other instances, well known to all seamen, are sufficient to show that the currents must be set in motion by some much more powerful and less *superficial* cause than the mere *friction* of the winds, however fixed or severe. That the winds agitate the *surface* of the waters no one will attempt to question; but that this agitation can extend to the vast depths at which the law of fluids above explained must operate, we have not the slightest reason to suppose. Major Rennell brings forward, in proof of his theory, the well known fact, that the surface of a canal, or of a lake, is always higher at the *leeward* than at the *windward* side. This fact is at once admitted, but it is one of very small effect, and merely *superficial*, being occasioned by *waves*, and instantly subsiding with these waves. But in order to prove the point, it must be shown, that in a straight canal of several miles in length, with a strong breeze right on end, the force of the winds, near the middle of the distance, (where they must have acquired their full force,) can affect an object of no great weight *at the bottom of the canal, and at a depth of four or five feet.* If this effect takes place in canals, or in large inland lakes, such as those of North America, and also at considerable depths, the theory might be supposed to derive some support from it. But this is not the case; and in inland lakes, of whatever extent, although the surface may be raised on the leeward side, in violent winds, objects deposited at a few feet of depth lie perfectly secure and unmoved.

The winds would not, therefore, effect the end for which the great circulation of the waters of the ocean is obviously intended; and any theory of the currents, which is mainly founded on so false a ground, however ably it may be treated, cannot but mislead the mind, and in many instances prove injurious, not only in a scientific, but also in a practical point of view.

* Major Rennell gives many interesting instances of bottles and other bodies carried by the currents. In one case a bottle was thrown overboard from the Osprey, of Glasgow, on the 17th of January, 1822, in 6° 13' south latitude, and 15° 35' west longitude, and it was found on the 29th of July of the same year, in Mayard Bay, in the island of Trinidad.

In another case, still more remarkable, a bottle was thrown from the American ship Lady Montague, on the 15th of October, 1820, two leagues north-east of the island of Ascension, and was picked up *on the west coast of Guernsey*, the 6th of August, 1821, and notice of it sent to the Admiralty. It is certain that this bottle must have passed, in ten months, over the whole course of the Gulf Stream, and from thence be carried (probably by the coasts of Iceland) into the North sea, and through the English Channel. We cannot, however, decide from this, or almost any instance of floating bodies, as to the *rapidity* of the current, for we cannot tell how long it may have been detained at various points, nor how long it may have remained on the spot where it was eventually discovered.

History of Chemistry. [Continued from page 108.]

Of Mercury.—Mercury, like some other metals, appears to have received its name from the planet, with which it was compared by the Persians on account of its nature, which was supposed to approach to that of gold, as this planet is nearest to the sun, and has been known since the most remote ages of antiquity. From a comparison of its qualities with silver, it was long ago termed *quicksilver*, *hydrargyrum*. In the species of hieroglyphics that were formerly employed for representing bodies, mercury was represented by the combined signs of the sun and moon, or of gold and silver, linked together, and supported upon a cross.

The alchemists have labored much upon this metal. They considered it as very much resembling gold and silver, and differing but very little from them; they imagined that it wanted but very little to become either the one or the other, and they always hoped to discover the means of transmuting it into these metals. Some of them have even affirmed, that they had succeeded in effecting this transmutation. These adepts agree with each other, that it is much more easy to convert it into silver than into gold. According to them, in order to convert it into silver, nothing more is required than to fix it. It was, therefore, in this fixation of mercury that they made all the art of their opus magnum, all the marvellous part of their science, to consist; this was the grand object of their attention, and the scope of all their wishes. All these pretensions, however, are not supported by a single well-attested fact; and the more we advance in the study of the properties of mercury, the more differences we find between it and the metals to which it has been supposed to approach the nearest.

The most celebrated philosophers, and the most able chemists, have all successively occupied themselves with this metal: they have endeavored to ascertain all its properties with more or less precision; and the use which has been made of it since the end of the last century, or since the time of Boyle, in the construction of a great number of philosophical instruments, has afforded frequent occasion for investigating and examining its different characters. It is in this manner that its weight, its phosphorescence, its dilatibility, its volatility, its alterability, its mobility, &c. have been successively ascertained.

The application of the pneumatic chemistry has connected together all the known facts relative to the chemical properties of mercury; it has given rise to the discovery of a considerable number of new ones; it has elucidated a great number of facts which before could not be explained; it has drawn from oblivion several which were neglected, or in a manner abandoned; it has dissipated all the obscurity, ambiguity, or uncertainty, that remained in the enunciation of its properties; it has conducted chemists to several important discoveries: such as the mutual differences between the greater part of the metallic or mercurial salts; the comparative state of the different oxides of mercury; the action of each oxide upon this metal or its oxides; the formation of several triple salts; the cause of the energy and causticity of the mercurial salts or oxides; the spontaneous reduction of these oxides; their decompositions by some of the metals; the nature and characters of several precipitates; the different states of some of its solutions; the extinction of mercury in a number of substances, which had always been considered as a simple division, but which, in reality, is a true oxidation. Mercury being one of the most useful of metallic substances for medical purposes, for the arts, and for all those branches of knowledge which extend our views of nature, we shall give a full detail of its properties.

Mercury is always fluid when in a pure state, and is one of the most brilliant and shining of all known metals. When its surface is sufficiently clear, it forms a very fine mirror. Its color is as beautiful as that of silver, with which it has always been compared. After platina and gold, it is considered as the heaviest of all known bodies. Its specific gravity is 13·568, taking water at 1·000. Authors were formerly very particular in observing that all the most ponderous substances swam upon its surface, whilst gold alone sunk in it; at the present day we have to add to this, platina and tungsten.

Boerhaave asserted, in his Elements of Chemistry, that mercury could not be rendered solid by any degree of cold, though he admits a condensation of $\frac{1}{150}$ of its primitive volume; a circumstance which cannot take place in its real congelation. This assertion of Boerhaave, and other philosophers who have followed him, was proved to be false in the year 1759; in which year the academicians of Petersburg, availing themselves of an intense degree of natural cold, augmented it still further by a mixture of snow and fuming nitrous acid; the mercurial thermometer which they used descended to 213 degrees of De Lisle's scale, which corresponds with 46 below 0 of that of Fahrenheit. As the mercury did not descend any lower, but seemed stationary, the academicians broke the glass bulb of their instrument, in which they found congealed mercury, that formed a solid sub-

stance susceptible of being extended by the hammer. They thus discovered that mercury might become solid, and that it in this state possessed a certain degree of ductility. They remarked that, at every stroke of the hammer, the pressure, developing the caloric in the interior of the metal, fused it, and that it ran into globules.

This first experiment was, in some measure, nothing more than a hint to philosophers concerning a property unknown, and till then even denied, in mercury; it has since been often repeated, and of late it has become as easy and simple an experiment as most of those that are made in Chemistry. In the year 1772, Pallas caused mercury to congeal, at Krasnejark, by a natural cold of —55½ deg. of Fahrenheit's scale. It was observed that it then resembled soft tin; that it could be flattened; that it broke easily; and that its fragments, when brought into contact, were glued or soldered together, as happens in all other softened metals. However, it is evident that he did not obtain its real conversion into a solid, or complete concretion, as the mercury was still soft, and only in a state of semi-congelation. In the year 1775, Mr. Hutchins observed the same congelation at Albany Fort, and Mr. Bicker at Rotterdam, in 1776, at 56 deg. below 0. In the year 1783, the congelation of mercury was effected in England with a less degree of cold; and Mr. Cavendish has proved 31¼ below 0 of Reaumur's, or 40 below Fahrenheit's thermometer, to be the real degree at which it takes place.

As a metal always fused, always liquid at the temperature of our climate, mercury constantly affects the form of perfect globules when it is divided. When inclosed in a glass phial or tube, its surface is convex, which depends upon the small attraction which it has for the glass; in fact, if we pour it into a vessel or tube of some metal with which it is able to combine, instead of remaining convex, its surface becomes concave. As this round, curved, and convex surface may give rise to some errors in barometrical observations, especially in those which are made with tubes of a fine bore, in which the elevation of the mercury ought to be an exact measure of the height of the places which we wish to determine, attempts have been made to obviate this source of error, by rendering the mercurial surface flat. Cassebois succeeded by boiling the mercury for a long time in the barometrical tubes; by which means a surface almost perfectly horizontal was obtained, especially in tubes of a wide bore.

The expansion of mercury by the action of fire has not yet been very accurately determined; it is known to be a very good conductor of caloric, on which account it appears very cold to the hand when immersed in it; and it is also owing to this conducting property that a red hot iron, when plunged into mercury, instantaneously loses its redness, which it would have retained for some time in the air, and even in water. Its expansion by heat proceeds in a very uniform manner; and it is on this account that it is employed in the construction of thermometers. When it is penetrated with a quantity of caloric, which has not yet been well ascertained, but which is estimated at 656 degrees of Fahrenheit's thermometer, the mercury swells, is reduced to the state of vapor, and volatilized. When this experiment is performed in the air, the mercury presently condenses into a white smoke, which is capable of producing very injurious effects upon animals. If it be performed in close vessels, in such a manner that the metal may speedily become fixed and liquified, this becomes a means of distillation, in which the habitudes of the volatile metal are the same as those of every other distilled liquid. In this operation, which is often employed for the purpose of purifying the mercury, it is customary to adapt to the neck of the retort of iron or stone ware which is used a tube of linen, the extremity of which is immersed in the water with which the receiver is filled. By means of this apparatus the mercury is speedily condensed into the liquid form, and collected entire under the water, from which it is afterwards separated by rubbing it with paper manufactured without size, drying it in a gentle heat, passing it through a skin, agitating it with very dry bread-crumbs, bran, and other desiccating means of a like nature. It is on account of this easy process of distillation that chemists have considered mercury as the most volatile of all metals.

Mercury is a very good conductor of electricity and galvanism. Its electrical property is probably the cause of the phosphorescence, and the considerably bright light which it emits when it is agitated in a vacuum. It has been discovered that this phosphorescence is an electrical phenomenon, which takes place only in consequence of the friction of the mercury against the sides of the tube, and that the mercury does not thereby suffer any sensible alteration.

Mercury is not altered by being kept under water. When exposed to the air, its surface is gradually tarnished, and covered with a black powder, owing to its combining with the oxygen of the atmosphere. But

this change goes on very slowly, unless the mercury be either heated or agitated: by shaking it, for instance, in a large bottle full of air. By either of these processes the metal is converted into an oxide; by the last, into a black oxide, and by the first, into a red colored oxide. This metal does not seem to be capable of combustion; at least, no method which has hitherto been tried to burn it has succeeded. It is the only metal which may not, by peculiar management, be made to *burn*.

Native mercury, which has been termed virgin mercury, is found in the form of liquid globules, which are very easily recognized by their brilliancy and liquidity. It is commonly found in tender and friable earths and stones, and frequently interposed between the fissures and the cavities of its own orbs, especially of its sulphuret. It is seldom perfectly pure, and frequently contains some other metal with which it is alloyed; but when it is sufficiently liquid, it is considered as pure, or really native. At Ydria, and in Spain, and America, it is collected in the cavities and clefts of the rocks, into which it filtrates from all sides. It is found liquid in argil at Almaden, and in the beds of chalk in Sicily. It is also found in the ores of silver and lead, and even mixed with the arsenious acid, or white arsenic.

Mercury does not combine with the simple incombustibles; but it combines with the greater number of metals. These combinations are known in chemistry by the name of *amalgams*.

The amalgam of gold is formed very readily, because there is a very strong affinity between the two metals. If a bit of gold be dipped into mercury, its surface, by combining with mercury, becomes as white as silver. The easiest way of forming this amalgam is to throw small pieces of red hot gold into mercury heated till it begins to smoke. The proportions of the ingredients are not determinable, because they combine in any proportion. This amalgam is of a silvery whiteness. By squeezing it through leather the excess of mercury may be separated, and a soft white amalgam obtained, which gradually becomes solid, and consists of about one part of mercury to two of gold. It melts at a moderate temperature; and in a heat below redness the mercury evaporates and leaves the gold in a state of purity. It is much used in gilding. The amalgam is spread upon the metal which is to be gilt; and then, by the application of a gentle and equal heat the mercury is driven off, and the gold left adhering to the metallic surface; this surface is then rubbed with a brass wire brush under water, and afterwards burnished.

Dr. Lewis attempted to form an amalgam of platinum, but succeeded only imperfectly, as was the case also with Scheffer. Morveau succeeded by means of heat. He fixed a small cylinder of platinum at the bottom of a tall glass vessel, and covered it with mercury. The vessel was then placed in a sand bath, and the mercury kept constantly boiling. The mercury gradually combined with the platinum; the weight of the cylinders was doubled, and it became brittle. When heated strongly, the mercury evaporated, and left the platinum partly oxidized. It is remarkable that the platinum, notwithstanding its superior specific gravity, always swam upon the surface of the mercury, so that Morveau was under the necessity of fixing it down.

There are few metallic substances that exceed mercury in utility. In physics, it is employed in its metallic form; in the construction of meteorological instruments, and a great number of machines in the arts, it is employed in the same form for gilding, silvering of glass mirrors, and in metallurgical operations; its solutions are used in dyeing.

In chemistry it is applied to a great variety of uses, all equally important. Besides the experiments in which it is employed for demonstrating the principal truths of this science, it has become of indispensible necessity for furnishing the vessels destined to collect, preserve, and combine many of the gases.

It is of equal importance for medicinal purposes.

Smoky Chimneys. By Comfort. To the Editor of the Mechanics' Magazine.

In the number of your periodical for January, there is an article headed "smoky chimneys," accompanied by rules for their cure, condensed from the works of Count Rumford.

It may be observed that the improvement in fire-places was proposed by Count Rumford with a view to economy in the article of fuel, and the suffusion through rooms of an increased quantity of heat from any given quantity of fuel. The Count, indeed, observes, that his plan of a fire-place will often act as a cure to smoky chimneys, but his chief object was economy in fuel, and his experiments had this as their chief, if not their sole object.

The result of his studies, scientific and operative, led to the conclusion, in his mind,

that four inches is the proper width for the throat of chimneys, and this will probably be found applicable to as many, or to more cases, than any other, which, as a general standard, could be adopted. It will not, however, be equally applicablè to all cases, nor will any general rule, in this respect, apply universally.

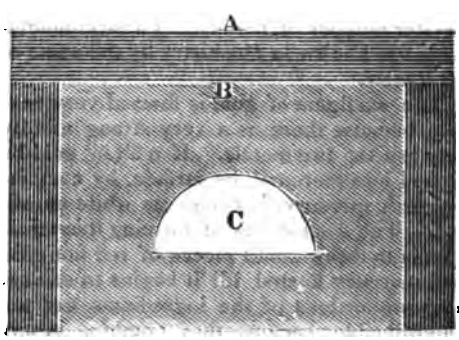
The proper width of the throat of a chimney is the least which will admit all the smoke, together with the quantity of rarified air necessary to aid its escape through the chimney. This must be regulated by circumstances, and chiefly by the material of the fuel. Anthracite coal, producing little smoke, would require a throat even narrower than four inches. Coal, of the quality of the Sydney, producing a large volume of smoke, might perhaps require a width of throat exceeding four inches.

The reasonableness of thus narrowing the throat of the chimney for the purpose of yielding an increased heat to the room, will, upon the least reflection, be sufficiently obvious. The smoke, if not impeded by some obstruction, will naturally ascend through the chimney; the heat of the fire, from its affinity to smoke, will ascend with it. Should the volume of air constantly rushing into the room find an over-easy passage through the chimney, the entire, or very nearly the entire, of the heat will escape with it; hence the fact, that persons sitting in a room, in presence of a large fire, often suffer from cold, and even in a degree greater than they would were there neither fire nor fire-place in the room.

A chimney may, however, be so narrow in some part of it, or throughout the whole, that it will not admit all the smoke, a part of which will, in such case, in search of a new channel of escape, make its way into the room. A similar effect will be produced when the chimney is so injudiciously constructed that the smoke cannot escape through it with the required ease and rapidity. A chimney may be so placed in relation to another chimney within the same building, as to cause it to smoke. These different causes of smoky chimneys may require very different remedies. Count Rumford's plan of narrowing the throat of a chimney will often effect a cure, but surely not universally. I propose herein to offer a remedy, which, although not proposed as an universal panacea, will, it is presumed, effect a cure in the majority of cases of smoky chimneys.

It is generally known that by lowering the mantle-piece the draft is increased, and the smoky chimney thus partially or fully cured; but it is also known that this mode will, by increasing the draft, lessen the quantity of heat in the room, and that warmth is in this way dispensed with, to avoid the annoyance of smoke. A plan which would yield the advantage of a lowered mantle without its disadvantages would be a desideratum. This is, perhaps, not to the full desirable extent practicable; it is certainly practicable to a considerable extent. It may be introduced in aid of the Count's plan, where that fails, as a remedy for smoky chimneys, or it may be adopted in cases where mere economy is not an object, or where it would be inconvenient to resort to the Count's plan.

On reference to the cut No. 2, in your Magazine of January, it will be seen, that in order to reduce the throat of the chimney, there is a false back. This is made of solid work, and is extended about six inches above the breast of the chimney, where the width of four inches is acquired, and is that part distinguished as the *throat*. We may suppose this false back to be in thickness equal to the length of a common brick, say eight inches. If made of the breadth of a brick, there would be a vacant space of four inches between the false and the real back. By turning an arch in the false back, or by an aperture of any other shape, there might be left an opening for the admission of smoke and air into the vacant space between the



A, chimney-piece—B, false back—C, aperture.

backs. This would produce all the effect of a lowered mantle, without producing all the inconvenience. The portion of inconvenience which it might produce would be entirely provided against by a metal casting fitted to the arch-way, and supplied with a door, to be closed or opened as occasion might require.

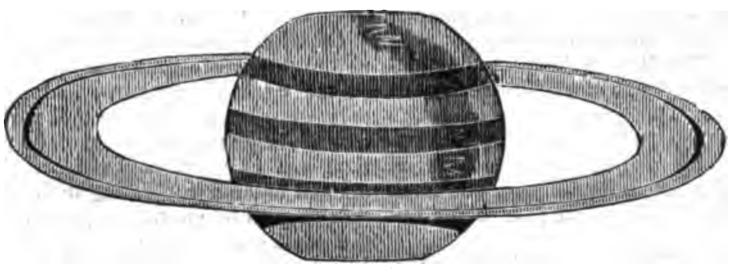
This contrivance would most probably relieve the occupants of houses, in nine cases out of ten, from the annoyance of smoky chimneys, and from the heavy charges of the chimney doctor. COMFORT.

History of Astronomy—its various Systems, &c. [Continued from page 103.]

Of Saturn.—The planet Saturn is 79,491 miles in diameter, and performs his revolution round the sun in 10,746 days, 19 hours, 16 minutes, at the distance of 903,690,197 English miles. His motion in his orbit is said to be 18,000 miles per hour; and the time he revolves on his axis 10 h. 16′ by some astronomers, and by others only 6 hours.

Saturn is distinguished from all the other planets by a large luminous ring surrounding his body, which was discovered by the celebrated Huygens, about the end of the 17th century. The same astronomer also discovered the fourth satellite, which attends this planet, and on that account is sometimes called the Huygenian satellite. The ring which surrounds Saturn appears double when seen through a good telescope, and is seen to cast a deep shadow on the planet. Dr. Herschel is of opinion that the ring has a motion round its axis; but this is doubted by Schroeter, and some other astronomers. Respecting the formation of this strange phenomenon, astronomers have been very different in their opinions, but the difficulty still remains as formidable as ever.

The annexed figure represents this planet as seen by Sir William Herschel, on various occasions, with his powerful telescope.



To Saturn the sun appears only one-ninetieth part of the size it does to the earth; and the light and heat which that planet receives from the sun are in the same proportion. But to compensate for the scantiness of light derived from the sun, Saturn has been observed to have no fewer than seven satellites revolving round him, besides the luminous ring that surrounds his body. The Huygenian, or fourth satellite, was the first discovered; the first, second, third, and fifth, were some years afterwards discovered by Cassini; and the sixth and seventh were discovered by Dr. Herschel, in the year 1789. These satellites are all so small, and at such a distance from the earth, that they cannot be seen, unless with very powerful telescopes.

The orbit of the planet Saturn was long considered as the boundary of the solar system, except the cometary orbits, which were always believed to stretch far beyond it. But by the discovery of the planet Georgium Sidus, this system has been extended far beyond the limits formerly assigned it.

Of Georgium Sidus.—A new planet was discovered by Dr. Herschel, on the 13th of March, 1781, and called by him Georgium Sidus, out of respect to his Majesty George III., but astronomers have given it the names of Herschel and Uranus. This planet is situated far beyond the orbit of Saturn, being at the immense distance of 1,822,568,000 miles from the sun. The time it requires to perform its revolution round that luminary is 83 years, 150 days, 18 hours. Its diameter is about 4½ times greater than that of the earth, or nearly 35,000 English miles. The distance of this planet from the sun being about double that of Saturn, can scarcely be discovered by the naked eye. However, when the sky is very clear, it may be perceived by a good eye, like a faint star of the fifth magnitude; but it cannot be readily distinguished from a fixed star with a telescope of a less magnifying power than 200. This planet is placed at so great a distance from the sun that it can receive but a very small portion of his light; however, this want is in some measure supplied by six satellites that revolve round it, all of which were discovered by Dr. Herschel. The periodic times of these satellites are as follows: The first is 5d. 21h. 25′; the second, 8d. 7h. 1′ 19″; the third, 10d. 23h. 4′; the fourth, 13d. 11h. 5′; the fifth, 38d. 1h. 49′; and the sixth, 107d. 16h. 40′. It is a remarkable circumstance that all these satellites move round the planet in a retrograde order, and that their orbits are nearly all in the same plane, almost perpendicular to the ecliptic.

NEW PLANETS.

Of Ceres.—The planet Ceres, which is

situated between the orbits of Mars and Jupiter, was discovered at Palermo, in Sicily, on the 1st of January, 1801, by M. Piazzi, an ingenious astronomer, who has since distinguished himself by his numerous observations. Ceres is of a ruddy color, but not deep, and appears about the size of a star of the eighth magnitude. It seems to be surrounded with a large dense atmosphere, and plainly exhibits a disc when examined by a telescope which magnifies about 200 times. Ceres performs her revolution round the sun in 4 years, 7 months, and 10 days, and her mean distance from that luminary is nearly 260,000,000 English miles. The eccentricity of her orbit is a little greater than that of Mercury, and its inclination to the ecliptic exceeds that of all the old planets. The magnitude of this planet is not yet well ascertained. Dr. Herschel makes her diameter only 160 miles, while Schroeter makes it 1624 miles. This great difference, says Schroeter, was occasioned by Herschel observing with his projection-micrometer at too great a distance from the eye, and measuring only the middle clear part of the nucleus.

Of Pallas.—The planet Pallas was discovered at Bremen, in Lower Saxony, on the 28th of March, 1802, by Dr. Olbers. It is situated between the orbits of Mars and Jupiter, and is nearly of the same magnitude with Ceres. It is of a less ruddy color than Ceres, and performs its revolution round the sun nearly in the same time. The atmosphere of this planet, according to Schroeter, is to that of Ceres in the proportion of two to three. It undergoes similar changes, but the light of the planet exhibits greater variations.

Of Juno.—The planet Juno, situated between the orbits of Mars and Jupiter, was discovered by M. Harding, at the Observatory of Lilienthal, near Bremen, on the evening of the 1st of September, 1804. While M. Harding was forming an atlas of all the stars which were near the orbits of Ceres and Pallas, he observed in the constellation Pisces a small star of the eighth magnitude, which was not mentioned by La Lande, in his *Histoire Celeste*, and being ignorant of its latitude and longitude, he put it down in his chart as nearly as he could estimate with his eye. Two days afterwards the star disappeared; but he perceived another that he had not seen before, resembling the first in size and color, and situated a little to the south-west of its place. He observed it again on the 5th of September, and finding that it had moved still farther to the south-west, he concluded that it was a planet. It is of a reddish colou, and free from that faint whitish light that surrounds Pallas. Its diameter and mean distance from the sun are less than those of Pallas or Ceres.

Of Vesta.—This planet, which appears like a star of the sixth magnitude, of a dusky color, similar in appearance to Herschel, was discovered on the 29th of March, 1807, by Dr. Olbers, who gave it the name of Vesta. In a clear evening it may be seen by the naked eye. Its light is more intense, pure, and white, than any of the other three new planets. The time it takes to perform its annual revolution is 3 years, 66 days, 4 hours. Its diameter is stated at 238 miles, and its mean distance from the sun at 225,000,000 miles.

OF COMETS.

Of all celestial bodies, comets have given rise to the greatest number of speculations. In the ages of ignorance and superstition, they were believed to be the harbingers of divine vengeance, and to portend great political and physical convulsions. The most ancient opinion respecting their nature was, that they were enormous meteors formed in the earth's atmosphere. Yet many of the ancients entertained opinions respecting them agreeing with some parts of the *modern* hypothesis respecting these bodies; for they believed that they were so far of the nature of planets, that they had their periodical times of appearing, and that when they were out of sight they were carried aloft to an immense distance from the earth, but again became visible when they descended into the lower regions of the air, when they were nearer to us. Modern astronomers are now generally agreed, that they have no light of their own, and appear luminous only by the light of the sun. They have no visible disc, and shine with a pale whitish light, accompanied with long transparent trains, or tails, proceeding from that side which is turned away from the sun. When a comet is viewed through a good telescope, it appears like a mass of vapors surrounding a dark nucleus of different degrees of opacity in different comets. As these bodies approach the sun their light becomes more brilliant, and after they reach their perihelion, often exceed any of the planets in lustre. Their tails are also observed to increase, both in length and brightness, as they approach the sun. The opinions of astronomers respecting these tails have been very different. Tycho Brahe, who was the first that gave the comets their true rank in the creation, supposed that the tail was occasioned by the rays of the sun passing through the nucleus of the comet, which he believed to be transparent. Kep-

ler thought that it was the atmosphere of the comet which was driven behind it by the force of the solar rays. Sir Isaac Newton maintained that the tail was a thin vapor, ascending by means of the sun's heat, as smoke does from the earth. Euler supposes that the tail is produced by the impulse of the solar rays driving off the atmosphere from the comet. Dr Hamilton, of Dublin, supposes them to be streams of electric matter.

In any of these opinions there is little to entitle it to preference above the others; and till multiplied observations shall have added to the imperfect knowledge which we at present possess of these bodies, it is perhaps better not to give a decided preference to any of them.

From a number of observations made by Sir Isaac Newton on the comet that appeared in the year 1680, he was enabled to discover the true motion of these bodies.

Dr. Halley, following the theory of Newton, set himself to collect all the observations which had been made on comets, and calculated the elements of 24 of them. By computations founded on these elements, he concluded that the comet of 1682 was the same that had appeared in the years 1456, 1531, and 1607; that it had a period of 75 or 76 years; and he ventured to predict, that it would appear again about the year 1758, which it actually did; therefore it may be expected to appear again in the year 1835.

When a comet makes its appearance, it is only for a very short period, seldom exceeding a few months, and sometimes only a few weeks. Instead of moving from *west* to *east*, like the planets in orbits making small angles with the ecliptic, they are observed to cross it at all angles. Their progress among the fixed stars is in general more rapid than that of the planets, and their change of apparent magnitude is much more remarkable. When a comet retires from the sun, its tail decreases and nearly resumes its first appearance. Those comets which never approach very near the sun have nothing but a coma or nebulosity round them during the whole time of their continuance in view.

The tail of a comet is always transparent, for the stars are often distinctly visible through it, and it has even been said, that on some occasions they have been seen through the nucleus or head. The length and form of the tail are very different. Sometimes it extends only a few degrees, at others it extends more than 90 degrees. In the great comet that appeared in the year 1680, the tail subtended an angle of 70°, and the tail of the one which appeared in 1618, an angle of 104°. The tail sometimes consists of diverging streams of light: that of the comet which appeared in the year 1744 consisted of six, all proceeding from the head, and all a little bent in the same direction. The tail of the beautiful comet which appeared in 1811 was composed of two diverging beams of faint light, slightly colored, which made an angle of 15° to 20°, and sometimes much more. Both of them were a little bent outward, and the space between them was comparatively obscure.

The apparent difference in the length and lustre of the tail of comets has given rise to a popular division of these singular bodies into three kinds, namely, *bearded*, *tailed*, and *hairy* comets; but this division rather relates to the several circumstances of the *same* comet, than to the phenomena of different ones. Thus when the comet is *east* of the sun, and moves *from* him, it is said to be *bearded*, because the light precedes it in the manner of a beard; when the comet is *west* of the sun, and sets after him, it is said to be *tailed*, because the train of light follows it in the manner of a tail; and when the sun and comet are diametrically opposite, the earth being between them, the train or tail is all hid behind the body of the comet, except the extremities, which being broader than the body of the comet, appear to surround it like a border of *hair*, and on this account it is called hairy. But there have been several comets observed, whose discs were as clear, round, and well defined, as that of Jupiter, without either tail, beard, or coma.

The magnitude of comets has been observed to be very different; many of them without their *coma* have appeared no larger than stars of the first magnitude; but some authors have given us accounts of others which appeared much greater: such was the one that appeared in the time of the emperor Nero, which, as Seneca relates, was not inferior, in apparent magnitude, to the sun himself. The comet which Hevelius observed in the year 1652 did not seem to be less than the moon, though it was deficient in splendor, for it had a pale, dim light, and appeared with a dismal aspect. Most comets have dense and dark atmospheres surrounding their bodies, which weaken the sun's rays that fall upon them; but within these appears the nucleus or solid body of the comet, which, when the sky is clear, will often give a more splendid light.

Respecting the nature of these singular and extraordinary bodies, philosophers and astronomers in all ages and countries have been very much divided in their opinions.

The vulgar have, however, invariably considered them as *evil omens*, and forerunners of war, pestilence, famine, &c.; and to adopt the language of an old poet,

> "The blazing star was viewed—
> Threat'ning the world with famine, plague, and war;
> To princes death; to kingdoms many crosses;
> To all estates inevitable losses;
> To herdsmen rot; to ploughmen hapless seasons;
> To sailors storms; to cities civil treasons."

The Chaldeans, who were eminent for their astronomical researches, were of opinion that comets were lasting bodies, which had stated revolutions as well as the planets, but in orbits considerably more extensive, on which account they are only visible while near the earth but disappear again when they ascend into the higher regions. Pythagoras taught that comets were wandering stars, disappearing in the superior parts of their orbits, and becoming visible only in the lower parts of them. Some of the ancient philosophers supposed they were nothing else but a reflection of the beams from the sun or moon, and generated as a rainbow; others supposed they arose from vapors and exhalations. The illustrious Aristotle was of opinion they were meteors. Modern philosophers have been equally perplexed as their predecessors in accounting for the nature of these magnificent celestial appearances.

The eccentric but learned Paracelsus gravely affirmed that they were formed and composed by angels and spirits, to foretel some good or bad events. Kepler, the celebrated astronomer, asserted that comets were monsters, and generated in the celestial spaces by an animal faculty! The sentiments of Bodin, a learned French writer of the 16th century, were yet more absurd; for he maintained that comets are spirits which have lived upon the earth innumerable ages, and being at last arrived on the confines of death, celebrate their last triumph, or are called to the firmament like shining stars!

James Bernoulli, a celebrated Swiss philosopher, formed a rational conjecture relative to comets, in viewing them as the satellites of some very distant planets invisible on the earth on account of its distance, as were also the satellites, unless when in a certain part of their course. Tycho Brahe, the illustrious but unfortunate philosopher of Denmark, supported a true hypothesis on this subject. He averred that a comet had no sensible diurnal parallax, and therefore was not only far above the regions of our atmosphere, but much higher than the moon; that few have come so near the earth as to have any diurnal parallax, yet all comets have an annual parallax; the revolution of the earth in its orbit causes their apparent motion to be very different from what it would be if viewed from the sun, which demonstrates that they are much nearer than the fixed stars, which have no such parallax.

Descartes advanced another opinion, which is, that comets are only stars that were formerly fixed like the rest, but becoming gradually covered with *maculæ* or spots, and at length wholly deprived of their light, cannot keep their places, but are carried off by the vortices* of the circumjacent stars; and in proportion to the magnitude and solidity, moved in such a manner as to be brought nearer to the orb of Saturn; and thus coming within reach of the sun's light, are rendered visible.

The number of comets belonging to the solar system is said not to be less than 450; but the periods of not more than three of these are known. The velocity of these bodies, and their distance from the sun, when in the remotest part of their orbits, exceed all human comprehension. Sir Isaac Newton calculated the velocity of the comet of 1680, and found it to be 880,000 miles per hour, and its aphelion distance not less than 11,200,000,000 miles.

Respecting the use of these bodies, many conjectures have been formed. Mr. Whiston thought it probable that they were appointed by the Almighty as places of punishment for sinners after *death*, who would be alternately tormented with the most insupportable *heat* when nearest the sun, and in the opposite point with the greatest possible *cold*.

Sir Isaac Newton, amongst other purposes which he thinks they may be designed to serve, adds, "that for the conservation of the water and moisture of the planets, comets seem absolutely requisite, from whose condensed vapors and exhalations all the moisture which is spent in vegetation, and turned into dry earth, &c. may be supplied and recruited, for all vegetables grow and increase wholly from fluids; and again, as to their greatest part, by putrefaction into earth. Hence the quantity of dry earth must continually increase, and the moisture decrease, and be quite evaporated, if it did not receive a

* Descartes supposed that every thing in the universe was formed from very minute bodies called *atoms*, which had been floating in open space. To each atom he attributed a motion on its axis; and he also maintained, that there was a general motion of the whole universe round like a *vortex*, or whirlpool. In the centre of this vortex was the sun, with all the planets circulating round him at different distances; and that each star was also the centre of a general vortex round which its planets turned. Besides these general vortices, each planet had a vortex of its own, by which its satellites (if it had any) were whirled round, and any other body that came within its reach.

continual supply from some part or other of the universe;"—"and I suspect," adds this philosopher, "that the *spirit*, which makes the finest, subtilest, and best part of our air, and which is absolutely requisite for the life and being of all things, comes from the comets."

On Undulating Railways. By A Civil Engineer. To the Editor, &c.

Sir,—Soon after the perusal of the experiments made by Mr. Badnall on the Liverpool and Manchester Railroad, I drew up the following strictures upon them, which I send for publication, if you should think that they will contribute to the objects of your Journal.

A Civil Engineer.

Mr. Editor,—You must pardon me—my patience is exhausted—I can no longer silently look on and see your respectable and useful paper countenancing an absurdity which nothing but the blindest species of infatuation (that of an inventor for his favorite project) can support after a moment's serious reflection, aided by a knowledge of the laws of nature. But I must pause—perhaps you have thought, from my abrupt beginning, that I was about to attack another Cataline: you are mistaken—I allude to Mr. Badnall's "undulating railway," and *especially to his late experiments on the Liverpool road*, which, it would seem, were seriously witnessed by Mr. Stephenson, the Engineer of that great work.

After reciting the experiments, the conclusions drawn from them are,—"That a locomotive engine can not only convey, on an *undulating way*, *double the load* which it is capable of conveying at *the same velocity* on a *level line*, but that it can accomplish this by the employment of *half its power*." [See page 28, Vol. iii.]

That Mr. Badnall should persuade himself of the truth of this most unphilosophical conclusion, is not a matter of much wonder; but that Mr. Stephenson, who is an eminent engineer, a man on whom the epithet 'great' has, on some occasions, been conferred, should sanction it, is to me a cause no less of surprise than regret.

I have declared his conclusions erroneous; it remains to sustain my position. With this view the following observations are premised:

It is a law of gravitation, that, if a body fall freely from a certain height to the earth, its velocity is *accelerated* at each instant of time during its fall: that, *cœteris paribus*, if the same body be projected upwards with the final velocity it had acquired by its fall, it will rise to the same height from which it fell, and in the same time, before its momentum will be destroyed by the same force which generated it, in its downward course.

Bodies moving on inclined planes follow the same general immutable law,—i. e., if a body be projected up an inclination with a certain initial velocity, it will advance up the plane until its momentum is exhausted by its gravitating tendency, when, if left free, it will return down the plane in a time equal to that consumed in its ascent, and at the end of its course will have acquired precisely the initial velocity of projection.

We hence perceive *that no more power or momentum can be generated by a body in falling down a plane than will carry it up an equal inclination in length and degree.*

These preliminaries made, we may remark that the first six experiments are of one class. We will abridge the 1st, 2d, and 7th, 8th experiments, which contain the substance of the whole set.

1st. "*Two* engines brought the train to a given point at the foot of the Sutton inclined plane, at which point they had attained a velocity of 19 miles per hour. One engine then left the train, and the other ascended with the load 575 yards in 116 seconds."

2d. "The power of the engine being reversed, the engine and load descended 575 yards in 64 seconds; the velocity attained at the foot of the plane being *far greater* than at the same point when *ascending*."

7th. "The two engines attained a velocity of 18 miles per hour at the foot of the ascent; one engine then left the train, and the other shut off her steam, when the whole train rose, by *momentum only*, 382 yards in 70 seconds."

8th. "The train descended (the engine working) 382 yards in 66 seconds."

In the first set of experiments there is an apparent inconsistency with the law of dynamics above given: that this is only specious, and not real, as Mr. B.'s fancy has led him to imagine, the latter set clearly prove, as I shall endeavor to show in what follows:

The rules of philosophizing seem to have been wholly lost sight of; for, instead of the inference the sanguine Mr. B. draws from 7 and 8, viz., that it can convey double the load, *with half its power*, they prove the fallacy of the preceding—at least, of the inference Mr. B. draws from them; and shew a remarkable coincidence with the laws above laid down. In short, these experiments, coinciding as they do with the known laws of falling bodies, ought to have suggested that, there not being a coincidence among all, there existed some defect, mismanagement, or other *adequate cause*, for the apparent disagreement of the first set with known laws: instead, these laws we find virtually pronounced incorrect; because, certainly not that his experiments actually prove them so—for any man reasoning *a priori*, from these laws, would have arrived at results similar to those which the experiments develope—but because, forsooth, it would seem they are *strange* (to him), and perhaps because they would not otherwise account for the preconceived principle of the undulating railway!

The poet may dwell upon the beauties of the visible world, and exclaim with rapture peculiarly his own,

"'Tis distance lends enchantment to the view."

Not so the philosopher. At the distance of 9000 miles he may throw his intellectual ken

across the Atlantic, and pierce the dark atmosphere of an inventor's prejudices in the pursuit of truth. Should the *inferences* drawn from these experiments (the facts are not contested) be true, there would indeed be a revolution, not only in railroads, but in the planetary roads; and possibly render it necessary to remodel those laws which have so long and so well answered the purpose of guiding the planets in their courses!—laws which, we are fain to believe, most of the world would be unwilling to dispense with, even for the bonus Mr. B.'s undulating railway system can confer upon them.

We think that the first of these philosopher's *stones*, of which Mr. B. claims to be the happy discoverer, will be reduced to its original *brass*, by the consideration that the train was projected up the plane by the *momentum* generated by *two* engines, and was assisted in its further progress by one. The *power* then is not as Mr. B.'s fancy has led him to imagine,—"that of one engine doing the work of two on a level,"—but of *one engine aided by the momentum generated by two engines before reaching the starting point*—a power as efficient and active, while it lasts, as that of the engine actually hitched to the train—a power which a form of words cannot annihilate. Had the train advanced to the starting point aided solely by the engine which was to accompany up the plane, we ask, what would have been the result? Why, plainly, the same as in the last set: equal times—equal velocities.

Unless then we can suppose that Mr. B. has discovered some method of condensing large quantities of momentum, which he may carry in his pocket, and infuse into his train before encountering one of the "bumps" of his "undulating railway system," our humble opinion is, that he will have to amend his first inference by striking out "double the load," and inserting "two-thirds, or one-half of the load," which it is capable of conveying at the same velocity on a level line: which opinion we expect to turn into an indisputable truth in the sequel of this paper.

Again, searching for the cause of the wonder which words have had the power to confer on these experiments—for the reason why, in falling down the plane, the train passes the foot at a *far greater velocity* than at the same point when ascending,—it should be borne in mind that, if the train had proceeded up the plane aided solely by the momentum generated before reaching it, the mass would have advanced until its momentum was exhausted, when, returning, it would have passed the foot of the plane in a time equal to that of its ascent, and at the same speed; adventitious circumstances, such as irregularities of motion, and consequently of friction upon the rails and otherwheres, as well as from the friction of the pistons of the engine, not being taken into account. The rationale of this discrepancy is readily given.

In addition to the momentum generated by the *two* engines, the train was assisted by one up the plane: this would operate to carry the train much farther up the plane than if left to its momentum alone; consequently, even if at the turning point this engine had been detached, the gravitating tendency would have caused the train to repass the foot at a far greater speed than it ascended with—since there was a much longer space in which to generate its velocity by the *accelerating* force. Partly from the same cause, and partly for the reason, that, after the momentum ceased to operate in propelling the load, it must have passed over the remaining distance to the turning point at a very slow rate, the time elapsing in the descent must have been much less than that expended in the ascent—offering, surely, nothing strange or unlooked for, one would suppose, by the experimentor; at least, I can vouch for it, by one who was not *alchemizing* for the "principle of the undulating railway." The experiment was actually more favorable to produce this disparity, *since the engine worked down the plane*, which would tend still farther to increase the difference of the times.

I am therefore quite at a loss to perceive the justice of inferring thence, that *because, under these circumstances*, the train *descends more rapidly*, and in a *less time*, over *a given distance*, "that one engine does the work of two on a level." The only inference warranted by the premises is, *that trains, under like circumstances, will always descend more rapidly and in less time than they will advance up a given inclination.* It is only by a computation of the performance of the engines in the experiment, and a comparison with the actual performance on a level, that we can pronounce upon their relative performance or advantage.

The last experiments, 7 and 8, show clearly a coincidence between the time of ascent and descent, when the train is influenced by momentum only in propelling up the plane, since the times, as noted, do not sensibly vary from equality; aside from *the working of the engine down the plane*, they would have come quite up to equality.

From this experiment he could only rationally infer, that the times of ascent and descent of planes under these circumstances is *nearly a ratio of equality:* and not that, "on the undulating plan, one engine can accomplish double the work *with half its power*," since the *relative* performance can only be ascertained by a comparison of the computed *absolute* performances on the plane and on the level. These computations I shall presently submit.

In short, the inferences Mr. B. draws from the experiments are about as much warranted by the premises as one would be in estimating the value of a quantity of vegetables from the known value of a pound of cheese.

We have seen that the fact of the descent being performed in less time than the ascent in these experiments, under these circumstances, is nothing strange, nothing new, and is consistent with the laws of dynamics; that the last experiment is a direct and plain corroboration of these laws; that the inferences drawn

from both sets are incorrect; that, consequently, any superstructure which may be erected upon them is—un chateau en Espagne.

These facts will appear more striking when I shall have answered the question—"What *practical result* may then be inferred from them?"

Submitting the performance of the first to calculation, we shall find that the rate exceeds but little over 12 *miles per hour;* but if the engines had been permitted to continue their course on the level, it would have been 19 *miles per hour.* We infer, then, that if a train of cars of the weight, and under the circumstances, of those in the experiment, be brought to the foot of a plane similar to the Sutton plane—if then one engine be detached, while the remainder proceeds up the plane until the gravity of the whole exhausts both the momentum generated by the two engines and the power of the accompanying engine—and at this point the power of the engine be reversed, and the whole return down the plane—that there will *always* be a *loss* by the *use of this method*, compared with that of the *two engines working on a level road*, in the ratio of 2 : 3, or one-third.

If we submit the performance of the two last to calculation, we shall find a result *below* 10 *miles per hour* for the actual performance. The performance on the level would have been 18 *miles per hour.* We infer then that there is a *loss* in the *use of the principle of "the undulating railway,"* under the circumstances of the experiments 7 and 8, in the ratio 10 to 18, or one-half.

As to curvature—shade of Newton!—that matter may be moved in a curved track at a *greater velocity* and *with less power* than in a straight line! is to say that bodies moving in curved paths do not always require an increase of power to propel them in the *direct* ratio of the *squares of the velocities*, and in the *inverse* ratio of the *radius of curvature!*—is to say that the more the curvature is sharpened, the greater the facility with which a body moves therein! (what a rapid flight we might make to the moon by a road curving like a succession of S's!)—is to say, that when a single force is resolved into its *components*, that a *part* is greater than the *whole!!*

Did the English Smeatons and Rennies, and the French Pronys, seriously approve of all this? or did they smile and shake their heads?

Albany, December 19, 1833.

Further Experiments on the Liverpool and Manchester Railway, to determine the correctness of the Undulating Railway System. [From the London Mechanics' Magazine.]

Sir,—I have this morning (29th October) received your numbers of the 19th and 26th inst. My principal object in now addressing you is to make an observation or two, which Mr. Cheverton's last communication immediately demands. In the course of a few days I shall trouble you with more general remarks in answer to "S. Y.'s" objections, to which the contents of your next number may possibly enable me to add something in further reply to Mr. Cheverton.

Mr. Cheverton says, in allusion to the comparative amount of resistance on the two lines, "Mr. Badnall will not undertake the task (of showing how trivial is the difference), because it will *disclose the poverty of his scheme.*" In the same breath, also, he observes, that "space will not allow him (Mr. Cheverton,) to show how trivial one is in comparison to the other."

Thus Mr. Cheverton, in a most unwarrantable manner, accuses me of withholding the truth when I have the power of publishing it, which *truth, if exposed,* would (he says) prove the poverty of my scheme; and yet, after nearly a *twelvemonth's* discussion, he, *for want of space,* declines to touch upon this subject. I appeal to all your readers, *is this generous?*

But Mr. Cheverton endeavors to sweeten this bitter observation, by saying, "I cannot believe that there is any intention to deceive, *yet it suits his* (Mr. Badnall's) *purpose better, (though it is not dealing fairly with the public,) to take a very short distance,* such as 147 yards," &c. &c.

There is no intention of deceiving, and *yet I am not dealing fairly with the public!!* I trust Mr. Cheverton will have the good feeling to revoke these expressions, or, at least, to explain them; and if not, I trust he will exclude Mr. R. Stephenson, Mr. Dagleish, Mr. Dixon, and the other engineers under whose joint inspection and superintendence most of the experiments were made, from any participation in a wish *to deal unfairly with the public.*

I am not one, Mr. Editor, who feels disposed to quibble about trifles, or, in discussions of this kind, to be disturbed by every burst of anger from an opponent whom, in this instance, *I feel within my grasp;* but I offer my unqualified protest against the right or propriety of any man attributing *unjust motives* to another, without a cause which he is able to substantiate.

Mr. Cheverton's remarks about inertia and gravity are becoming as familiar to me as my "*hic, hæc, hoc.*"

His simile of "the two boys with a swing," would, I should have imagined, (as some time ago alluded to by your correspondent "Saxula,") have led him to reflect rather more deeply on the subject before us. Had I told him, before this discussion was entered upon, that I could, by means of my own arm, and without the aid of any assistant artificial power, raise a ton weight above the level of my head, he would not, perhaps, have believed me; yet he knows very well, that if a ton weight were suspended but a few inches from the earth by a rope of sufficient strength and length, and from a prop of sufficient strength, there could be no difficulty, by gradually increasing the oscillations of the load, in attaining the required elevation,—nay, by the simple application of an equally simple contrivance, to retain the load at that very elevation when attained. Now, although throughout each oscillation of this pendulum, the effect of gravity from each de-

scent of the weight may be said to be destroyed in the corresponding ascent, would the power of gravity, or would it not, be auxiliatory in the accomplishment of this task?

With regard to 147 *yards* being too limited a distance to suit the trial of a fair experiment, Mr. Cheverton must blame the locomotive engine, not me. The inclined plane is 1½ mile in length, and if the Rocket engine had not sufficient power to reach a higher elevation, was it *my fault*? The experiments which were *last* tried will surely satisfy Mr. Cheverton that he has done me injustice, in supposing that I *chose* the *worst engine*, from any supposition that *it would best support my arguments on this subject.*

As it appears that the deductions which are drawn by engineers from these experiments, are not fully understood by many who have perused the particulars of them, I shall beg your insertion of a diagram, published by the editor of the Manchester Guardian, which will probably be found to render my ideas as clear as they can be rendered on this subject:

A B is a level line—B C, equal to B D, forming an undulation D B C, whose summits are of equal altitude.

The train of loaded carriages, weighing 150 tons, and moved by two engines, one dragging, the other propelling the load, had acquired from A to B (the length of this line being one mile on the railway,) a velocity of 20.28 miles an hour. On arriving at B the steam of the propelling engine was shut off, and the engine stopped. The train, then, partly by the momentum acquired in travelling over the level railway, and partly by the power of the remaining engine, ascended the inclined plane to the point C, viz. 575 yards, which was as far as the united locomotive force of one engine and the momentum could carry it. The power was then reversed, and the engine pushed the carriages back from C down the inclined plane to B, at which point it was found that the descending velocity was 31.70 miles an hour. Now, as the velocity of 20.28 miles an hour at B was sufficient, with the aid of *one engine*, to carry the whole train from B to C, what man living will dispute that a velocity of 31.70 miles an hour, at the same point, would, with the same engine, have enabled the train to ascend the line B D, which is supposed to be precisely equal to the line B C? On the contrary, would there not be *a given velocity* generated at the point D, which, the effective power of the engine being still continued, would have enabled the train to pass over another *like* undulation? If so, one engine could move 150 tons along the undulation C B D, which amount of tonnage she could not move on a level road, and which *on a level road, whatever velocity was given to the train at starting, would bring the engine gradually to a halt.*

But let Mr. Cheverton direct his attention to the two last experiments which were tried. If *a momentum* (*momentum only*), arising from a velocity at the point B of 19.04 miles per hour, carried the train 323 yards—say as far as *e* on the inclined plane B C—would not a momentum, arising from a velocity of 20.04 miles per hour, carry the same train to the point *f* up the ascent B D? If so, the Firefly engine proved her capability of moving 150 tons along an undulation *e* B *f*, by the employment of her power throughout only *half* the distance, and if this were the case over *one* undulation, will Mr. Cheverton deny that *such would have been the case over succeeding undulations*?

During the next week I may, perhaps, have an opportunity of trying a few more experiments: if so, they shall be transmitted to you. I have expressed my opinions to the *Liverpool Directors*, that the *Firefly engine* is capable of conveying from one summit of an undulation to another the enormous load of from 200 to 250 tons. I may have exceeded the limits of her power in this prophecy; but will Mr. Cheverton admit one point before he hears the result of any further experiments? viz. that *if the Firefly*, or any other engine, can move even 200 tons from summit to summit of *one* undulation, that she is capable of moving an equal load from one summit to another summit of a *second* or greater number of like undulations?

If so, what becomes of his weakest and most untenable argument, that *all I gain* is the comparatively *trifling advantage which gravity gives me at the commencement of locomotion*? I am, Sir, with great respect, your very obedient servant, RICHARD BADNALL.

October 29, 1833

N. B.—The subject of friction, (trivial as Mr. Cheverton thinks it,) I shall not be ashamed to discuss in my general answer to "S. Y."

The Late Experiments made on the Liverpool and Manchester Railway, to determine the accuracy of the Undulating Railway Theory. [From the London Mechanics' Magazine.]

SIR,—The truth of Mr. Badnall's statements of the experiments on the Sutton inclined plane being of importance to those who have no other means of forming their judgment upon the undulating railway theory, I take the liberty of asking that gentleman, through the medium of your Journal, which contains his account of the trials on the 23d and 24th of September (see No. 530,) how it happens that your printed statement doth vary from the verbal one which he was so polite as to give me at the Star hotel, Liverpool, on the evening of the said 24th, in the presence of Mr. Perkins the engineer, and several other gentlemen? Mr. Badnall read from his note-book, carefully and distinctly, while I wrote down his words (in ink), which, at my request, were repeated by him to prevent mistakes, and I have now the memorandum before me. Mr. Badnall will recollect, that I told him *the same night* that the results did not accord with each other, if the inclination of that part of the Sutton plane,

upon which the experiments were tried, was really as great as he had assumed it to be—namely, 1 in 96.

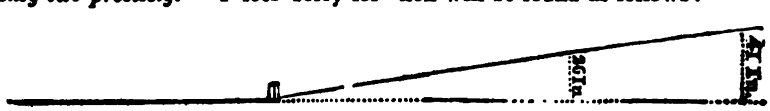
The statement which Mr. Badnall then deliberately gave me was as follows, and refers only to the first, second, and eleventh experiments:

"Weight of the Rocket engine and tender, 6¼ tons; wheels 4 feet 8 inches *diameter*. *First*—Began the ascent (without steam) at the rate of 18 miles an hour (equal to 18 *strokes of the piston in 10 seconds*), and ran up the inclined plane to a distance of 217 yards, by *momentum*. *Second*—Returned to the foot of the inclined plane (using the full power of the engine), and acquired a velocity of 22 miles an hour (or 22 strokes of the piston in 10 seconds); shut off the steam, and ran, on the level plane, to a distance of 454 yards, by *momentum*. *Eleventh*—Two engines took a load of 35 tons on the level, and reached the foot of the inclined plane with a velocity of 12 miles an hour (or 12 strokes of the piston in 10 seconds). One of the engines being left behind, the other (the Rocket) shut off the steam, and ascended a space of 177 yards, by *momentum*."

The statement with regard to the *last* experiment, it will be seen, agrees with your printed account; but the two first do not, as to the fact of the acquired velocity; yet it is a truth which Mr. Badnall will not deny, that I at first understood him to say "*twenty to twenty-two miles an hour;* but, upon my repeating those words, thinking the expression too vague, he corrected me or himself by saying, "*twenty-two precisely*." I feel sorry for the necessity of calling upon Mr. Badnall to explain how it was that, four days afterwards, he should send you so different an account for publication. Did he mean to deceive me, or your readers? In either case, I opine, he will be considered as having rather too much of "the man of the world" in his composition. I should have taken this step before now, had I seen the paper in No. 530 sooner; but I did not get it till the 2d inst. in the last monthly part, and have since then been closely engaged in my regular vocation.

Being desirous of finding out the error, for I felt assured of its existence, and Mr. Badnall having returned to the Isle of Man, I wrote to Mr. Booth on the subject, of which letter the following is a copy:

"Sir,—Having been invited by Mr. Badnall to witness the experiments on the Sutton plane on Tuesday, the 24th ult., I went there on that day, but, as you will probably recollect, was too late for personal observation; for, at the moment I arrived, the Rocket engine had received some damage, and Mr. Badnall, with yourself, was on the point of returning to Liverpool by the same train. Mr. Badnall gave me the principal results on our arrival at his hotel in Liverpool, which I cannot at all reconcile, upon the supposition that the inclination of *that part* of the Sutton plane is 1 in 96. Perhaps the quarter-mile post which you assumed as the *foot* of the plane is not precisely so, or some alteration may have taken place since their first construction. If accurate levels are taken, I am inclined to think the section will be found as follows:



"Should you think it necessary to have actual levels taken for the purpose of corroborating the other facts, will you have the goodness to favor me with the result? And you will further oblige by informing me when you next try experiments with reference to the undulating theory, and by allowing me to be present during the trial. I am, sir, your obedient servant, H. S.

"Sheffield, Oct. 1, 1833.

"*Postscript.*—I ventured to tell Mr. Badnall on the same evening, that there must be some material error, and that I thought it was in the assumption of 1 in 96 for the inclination. This well-meant observation, however, did not appear very palatable.

"To Henry Booth, Esq., Treasurer to the Liverpool and Manchester Railway Company."

It is to be regretted, for the sake of truth, and Mr. Booth's acknowledged character as a gentleman and a lover of science, that all the notice of this communication which I have had the honor to receive, is contained in a postscript of an unlooked-for letter from Mr. Badnall, dated October 19th. He says,—"Your letter to Mr. Booth may lead you to a better acquaintance with the precise inclination of the Sutton inclined plane; but, however the inclination may vary from the reputed rise, it cannot affect the proportionate result of experiments." True, it cannot; but it affords the means of *checking* the statement of Mr. Badnall; and there would have been another check, if that had been done which on the 24th September I said ought to have been done, namely, accurate observations recorded of the *length of time* occupied in traversing the respective spaces by means of the acquired *momenta*. This hint, it appears, has not been forgotten in trying the subsequent experiments, and its being acted upon may be attributed to Mr. Robert Stephenson, of Pendleton, who perfectly agreed with me in opinion as to its propriety. [See Liverpool Mercury of October 18.]

As soon as I am more at leisure I shall send you some further ideas on the undulating railway theory, which I will endeavor to condense as much as possible, and will not forget the friendly notices of your correspondents "Junius Redivivus" and "S. Y." Yours, respectfully,

Henry Sanderson.

Sheffield, Nov. 10, 1833.

Mr. Badnall's Explanation of the Alleged Discrepancies in the Reports of the Recent Experiments on the Liverpool and Manchester Railway, to determine the correctness of the Undulating Railway Theory. [From the London Mechanics' Magazine.]

Sir,—I feel indebted by the opportunity you have afforded me of explaining the cause of the difference between the statements alluded to by Mr. Sanderson, and those sent by me to you for publication. I have no doubt that Mr. Sanderson copied my observations correctly; and those observations, at the time I communicated them to him, I believed to be perfectly correct. Mr. Sanderson is aware that, on the day the experiments were tried, I was laboring under severe indisposition; and, as the weather was extremely inclement, I did not take the same active part in the experiments as Mr. Booth, Mr. Rae, and Mr. Scott. The observations I made, as they appear in my note-book, in regard to the velocity of the engine and train at the foot of the ascent, were founded on my own calculation of the number of strokes which the engine appeared to be working when she passed the spot on which I stood. The spaces passed over were measured, and the particulars agree with the statement which I gave to Mr. Sanderson. Immediately after the experiments were concluded I proceeded to Liverpool with Mr. Sanderson, whom I met in one of the railway carriages; and the same evening I gave him the particulars to which he alludes. He will perfectly recollect that the following day I was not, through indisposition, able to get up till one o'clock; and, having an arrangement at Manchester, I could not, on that day, compare my notes with Mr. Booth's. At *two* o'clock I left for Manchester, and gave, at Newton, the same particulars which I had given to Mr. Sanderson to *Mr. Allcard*. On the 26th of September I left Mr. Sanderson in Manchester, and returned to Liverpool; and, previously to addressing you, I considered it better to have an interview with Mr. Booth, who was in possession of the notes taken by Mr. Rae and Mr. Scott, and who had himself carefully taken down all the particulars. At this interview I found that I had over-estimated the velocity at which the piston was moving; and the statements, therefore, which I sent to you were *not my own*, as given to Mr. Sanderson, but those of three other individuals, which decidedly told more *against my principle* than *my own* would have done.

For instance, had the engine been travelling at eighteen miles an hour at the foot of ascent, before rising the hill, and twenty-two miles an hour at the same point, after descending the hill, which are the particulars given to Mr. Sanderson, the result would have shown a greater gain by the undulating system than when the velocities were fifteen strokes of the piston (or about fifteen miles an hour) before ascending, and sixteen strokes of the piston (about sixteen miles an hour) after descending, as published in your Magazine.

I have only to add, that in all the statements of the experiments which I *have sent to you*, I have cautiously avoided laying myself open to the slightest charge of error or partiality. On the contrary, my notes have always been corrected by, and compared with, the notes of others.

With regard to the particular inclination of the Sutton inclined plane, it has always been understood to be about *one* in ninety-six. After my first experiments were made, however, the levels were taken afresh, and it was found, that towards the foot of the plane the inclination was considerably less than the average rise. For instance, from the point from which the ascent of the Rocket engine, &c. was calculated, the plane rises as follows:

1st 88 yards,	. . . . . .	1 in 122.
2d do.	. . . . . .	1 in 105.
3d do.	. . . . . .	1 in 97.
4th do.	. . . . . .	1 in 94.
5th do.	. . . . . .	1 in 92.
6th do.	. . . . . .	1 in 89.
7th do.	. . . . . .	1 in 89.

And the entire distance here denoted exceeds that to which, in any of the experiments, the train ascended.

It must, however, be evident, that however a variation in the inclinations may affect Mr. Sanderson's calculations, it cannot possibly,—which he will, no doubt, allow,—affect the comparative results of the experiments.

I remain, sir, yours, &c.,

Richard Badnall.

Farm-hill, near Douglas, Nov. 19, 1833.

N. B.—There can be no doubt as to the measurement of time being the best test; which test was adopted in all the subsequent experiments, as agreed upon by the engineers present.

American Patents in England.—The following extract of a letter from a gentleman in England, to his friend in this country, may be useful to those who desire to take out patents in Europe.

Extract of a letter from London, dated 14*th December*, 1833.

"It may be of use to apprize inventors of mechanical improvements in the United States, that it is essential to the security of their interests, if they design to take out patents for their inventions in this country, not to disclose the secret of their inventions in the United States until they have secured a patent here. There are many ingenious mechanics in the United States, in correspondence with their friends in this country, constantly upon the watch to seize any thing new and likely to be useful, and to transmit the particulars to their friends, and thus forestal the rights and interest of the original inventor."

New Ink Distributor.—We were lately shown, by Warren Jenkins, of this town, a new or improved machine, invented by himself, for regulating, with mathematical exactness, the distribution and application of ink to

the types. This machine is the first attempt of the kind by the inventor, and, therefore, imperfect in some of its mechanical details; but, in its present condition, it answers the intended purpose very well. We have scarcely a doubt that the principle upon which the machine is constructed is correct, and that a more perfect mechanical construction of all its parts will make it fully to answer the purposes for which it is designed.

Should our anticipations be realized, and there seems little room to doubt that they will, an ordinary pressman, with the assistance of a boy capable of moving the *rollers*, can take any number of *clear*, *uniform* impressions, extending throughout a whole *form* or a whole book. This machine will, therefore, be no less important to readers who desire beauty and uniformity in what they read, than to printers who are responsible for the quality of their work.

When the machine is once regulated so as to take a suitable quantity of ink, which will be the labor of but a few minutes, the pressman is relieved from further care in relation to the uniformity of the impressions, as the application of the ink to the rollers is entirely beyond the control of the boy who does the rolling. We may also add, that the machine is of simple construction, and of course, little liable to get out of order; whilst the cost will probably place it within the reach of every person owning a press. Several other advantages might be enumerated, but we think enough has been said to entitle it to the consideration of printers.—[Cincinnati Journal of Science.]

Straw Cutting Machine.—A few weeks ago, we purchased for a subscriber on the eastern shore of Maryland, one of Sinclair & Moore's straw cutters, of the middle size. We this week received from him the following testimony of its excellence, which we publish rather for the benefit of the public, than for that of the worthy manufacturers. By the way, it seems to be universally allowed by all who have tried it, that the saving by the cutting of *all long food* for stock is a very important one. We have noticed the testimony of farmers, of graziers, of dairy-men, and of stage proprietors, all to the same point, and have never heard one state a contrary opinion against it. Those who have tried steaming this cut food, seem to agree pretty unanimously that this operation improves its quality still as much more. Surely these facts are worthy the careful attention of all concerned in the feeding of cattle and horses—but here is an extract from our friend's letter:

"I am delighted with my straw cutter. It will have saved all the money it cost before May-day. The 'meat, drink, washing and lodging,' of *each* of my carriage horses, cost me the last year at least $100: by means of the straw-cutter, I can give them better board, keep them sleeker and happier; and (at the present price of produce) *both* of them, the current year, will not cost me more than $60. I shall be the means of procuring a market for several straw-cutters, at which I rejoice, not on account of the seller, but the buyer.—[Amer. Farmer.]

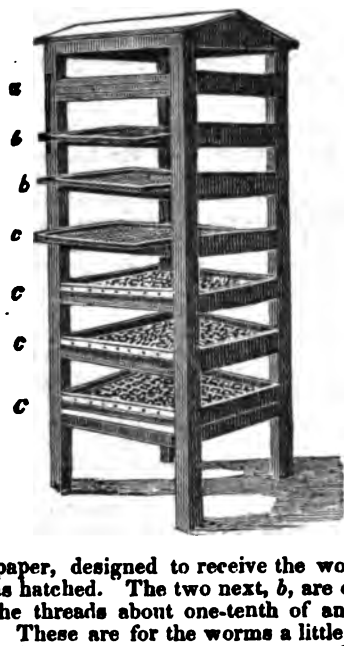
Consumption of Silk.—The quantity of this material used in England, alone amounts each year to more than four millions of pounds weight, for the production of which, myriads upon myriads of insects are required. Fourteen thousand millions of animated creatures annually live and die to supply this corner of the world with this luxury! If astonishment be ascribed at this act, let us extend our view to China, and survey the dense population of its widely spread region, whose inhabitants, from the emperor on the throne to the peasant in the lowly hut, are indebted for their clothing to the labors of the silk worm. The imagination, fatigued with the flight, is lost and bewildered in contemplating the countless numbers which every successive year spin their slender threads for the service of man.—[Repertory of Patent Inventions.]

Statistics of Brewing in England and Scotland.—There were 216 brewers in Scotland last year, of which above 33 are in the Edinburgh collection. Argyll has only one. There are 17,070 licensed victuallers in Scotland, which is 1 for every 128 persons, young and old, in the country; and though grocers who sell beer are evidently included with innkeepers, the proportion is still very great. England, which is a *thirsty* country, rejoices in 50,800 victuallers, and 30,000 "persons licensed for the general sale of beer," making an aggregate of 81,-700 retailers of beer, which is 1 for every 170 souls. England has 1753 brewers, of whom 108 are in London. Of the retailers of beer, 37,000, or nearly one-half, brew their own beer. In Scotland, only 318 out of 17,070, or 1 in 57, brew their own beer. In Scotland, 990,000 bushels of malt were used for brewing in all the 16 collections, of which one-tenth was used by the licensed victuallers; 432,000 bushels were used in the Edinburgh collection; 62 bushels served the two collections of North and South Argyll, containing 100,000 souls. In England, 25,800,000 bushels of malt were consumed in the manufacture of beer: 13,800,000 by the brewers, and 12,000,000 by the victuallers or other retailers. In Scotland, the malt brewed is at the rate of four-tenths of a bushel for each person; in England it is 1¾ bushel. Ireland consumed 1,540,000 bushels of malt in her breweries, which is about two-tenths of a bushel for each person. Of brewed liquor, *one* Englishman drinks as much as *four* Scotchmen, or *nine* Irishmen. In 1831, there were 928,000 bushels of malt used for brewing in Scotland, of which 834,000 were used by the brewers, the rest by victuallers. In 1830, the Scotch brewers consumed 740,000, but the paper from which this is taken does not mention the victuallers. The increase in the quantity of malt used by the brewers since 1830 seems to be about *one-fifth*.

Rearing of the Silk Worm. [From the New-York Farmer.]

Apartments.—Almost any building will answer for rearing the silk worm; a barn, garden, apartments of the dwelling-house, provided they are dry, can be properly ventilated without exposing the worms to chilling currents of air, and kept free from insects, mice and other vermin. Boards, shelves, tables, or shallow boxes, will answer in absence of other more convenient apparatus.

The apparatus of the Rev. Mr. Swayne is recommended from its simplicity and convenience—rendering the apartments capable of being easily kept clean. It is a wooden frame, four feet two inches high, each side sixteen and a half inches wide, divided into eight partitions, by small pieces of wood, serving to form grooves, in which the slides, containing the worms, run in and out. The upper slide, *a*,



is of paper, designed to receive the worm as soon as hatched. The two next, *b*, are of catgut, the threads about one-tenth of an inch apart. These are for the worms a little more advanced. The four lower ones, *c*, are of wicker work, split rattan, or netting, with openings of a quarter to half an inch square. Under each of these is a slide of paper, to prevent the dung from falling on those below. Spare drawers should be made for the two upper ones. When the worms are grown so large as to require more room, they are removed to large drawers of netting, or wicker work, where they remain until they show signs of a desire to spin.

The Eggs.—The fecundated eggs turn from a pale yellow color to a brownish slate color. They are kept in a convenient place—in a dry cellar, in a box, where they will not receive injury from mouldiness, and from mice, until the mulberry begins to throw out leaves. They are then placed in the kitchen, or other suitable place, where the warmth of the air will hatch them in a day or two.

Feeding the Worms.—It is desirable to have all the worms designed to be reared, hatched at the same time. As soon as they appear, the tender leaves, or trimmings of the mulberry, are gently laid over them. If they are fed with leaves they will require a fresh supply three times a day; if with the trimmings, once or twice will be sufficient. To prevent the leaves from becoming dry, they are kept in a cool place, in a glazed vessel, or by laying a board over them. The leaves, if gathered in wet weather, should be dried before they are given to worms. It is best, therefore, to gather a sufficiency for three or four days at once in fair weather. The older the worm the larger the leaves suitable for them.

Cleaning.—The shelves, or whatever the worms are placed on, should be carefully and frequently cleansed. Sometimes the boards are covered with old newspapers, which are turned and renewed. The worms can be changed from one part of the shelves to another by taking them up in the fingers, or by removing the leaves on which they are eating, and thus affording an opportunity to brush away the litter.

Different Ages and Moulting.—The most common varieties, of which the large white is recommended as the best, change their skins four times. These changes, called moultings, divide the life of the worm into five ages. The first moulting generally takes place on the fifth or sixth day after hatching, the second on the eighth, the third on the thirteenth or fourteenth, and the fourth on the twenty-second.

Before the worms moult or change their skins, they are less active, and indicate sickness or distress, by raising their heads. They should, in this situation, be disturbed as little as possible, and fed very sparingly.

Spinning.—When disposed to spin, the worms, true to the laws of their nature, will cease to eat, and begin to wander about. They now should be immediately supplied with conveniences for spinning, by placing on their shelves regularly made handles, brushwood, or broom corn. The last, if properly secured and spread out or pressed against the upper shelves, as recommended by G. B. Smith, Esq., of Baltimore, are the best. The worms will readily ascend these little trees, and diligently commence their useful work. Each one will spin its cocoon in three or four days; and in about six or eight days, they all will have finished their labor.

Breeding or Seed Cocoons.—The largest, best formed, and most firm cocoons, should be selected for the eggs of the future brood. The coarser floss, or wool silk, may be taken off, and hung on a thread, by the aid of a needle, without piercing the cocoons. In about a week or more the moths or butterflies will eat their way through the cocoon. They will now couple, and, by taking them in pairs, by the wings, they may be put, as many as convenient, on sheets of paper, where they will remain and deposit their eggs. When they are done laying they soon die. The sheets can be folded up,

and put in a dry and cool place until the following spring. If allowed to remain in a warm room they will hatch. The sun should not be allowed to shine upon them at any time; and the room where the millers lay their eggs should not be molested by cats, mice, or insects.

CURING COCOONS.—When the cocoons cannot be reeled immediately after they are spun by the worm, the encircled chrysalis must be killed to prevent it from eating out, and thus destroying the cocoon for reeling. They are put in shallow vessels, or in baskets, and then placed in an oven moderately heated, to remain half an hour. Another method is steaming them. Mr. Smith, of Baltimore, recommends them, when raised on a small scale, to be put in a tight tin vessel, which is surrounded with another containing water heated, until the cocoons become as hot as boiling water. After this, they are spread out to dry. The per-centage lost in the weight by curing is about 25, depending on the dryness. The cocoons will reel better immediately after they are finished by the worm.

SPACE FOR THE WORMS.—It is desirable that they should not touch each other. An ounce of good eggs will produce about 40,000 worms. The space these will require in their five ages may be in a proportion not far from the following square feet, 8, 16, 36, 86, 186.

DISEASES OF SILK WORMS.—These are described as being numerous, and sometimes very destructive; but wholesome air, perfect cleanliness, avoiding feeding with wet leaves, are preventives. Chloride of lime has been recommended by some to purify the rooms, and others have found it injurious. If used, it should be sparingly. The fifth age is considered the most critical.

QUANTITIES OF SILK FROM COCOONS.—The estimates, in respect to the silk from the cocoons, are various, depending on their size and quality. We obtained one pound (16 oz.) of sewing and gloss silk from one bushel, containing 1940 cocoons, which were two years old. Mrs. Williams obtained nearly one and a half ounces from 244 cocoons. Miss Rhodes one ounce from the same number. The calculation of those who have had experience is from 2000 to 4000 cocoons for a pound of silk.

PROFITS.—It is very difficult to make an estimate of the profits from raising silk worms. It is a fact that our climate is congenial to the worm and the mulberry. It is another fact that many millions of money are annually expended for foreign silk in various states of preparation and manufacture. These facts afford ample encouragement. The actual profits will depend on various other circumstances: whether the trees are set in lanes, avenues, unoccupied grounds, hedges, or in orchards—whether carried on a large or small scale—whether expensive or cheap labor is obtained. Like all other pursuits, its success depends on care and attention. The Morus multicaulis will undoubtedly be the most profitable tree to feed the worms.

The following estimate was by John Fitch, Esq. of Mansfield, Ct., in the Manual published by Congress. One acre of full grown white mulberries, set at the distance of one and a half rods, will produce 40 lbs. silk. For the first three weeks after the worms are hatched, one woman will do all the labor. For the next twelve or fourteen days five persons are required. During this last period there should be one or two men. If children are employed, a greater number than five are required. The picking of the balls and reeling the silk can be done by about the same number of women and children in ten to fifteen days. The lowest cash price is $5 per pound.

40 lbs. at $5		$200
Labor and Board	$80	114
Spinning	34	
Net profit per acre		$86

FEMALE EDUCATION.—Let your first care be to give your little girls a good physical education. Let their early years be passed, if possible, in the country, gathering flowers in the fields, and partaking of all the free exercises in which they delight. When they grow older, do not condemn them to sit eight listless hours of the day over their books, their maps, and their music. Be assured that half the number of hours passed in real attention to well ordered studies, will make them more accomplished and more agreeable companions than those commonly are who have been most elaborately finished, in the modern acceptation of the term. The systems by which young ladies are taught to move their limbs according to the rules of art, to come into a room with studied diffidence, and to step into a carriage with measured action and premeditated grace, are only calculated to keep the degrading idea perpetually present that they are preparing for the great market of the world. Real elegance of demeanour springs from the mind; fashionable schools do but teach its imitation, whilst their rules forbid to be ingenuous. Philosophers never conceived the idea of so perfect a vacuum as is found to exist in the minds of young women supposed to have finished their education in such establishments. If they marry husbands as uninformed as themselves, they fall into habits of insignificance without much pain; if they marry persons more accomplished, they can retain no hold of their affections. Hence many matrimonial miseries, in the midst of which the wife finds it a consolation to be always complaining of her health and ruined nerves. In the education of young women we would say, let them be secured from all the trappings and manacles of such a system; let them partake of every active exercise not absolutely unfeminine, and trust to their being able to get into or out of a carriage with a light and graceful step, which no drilling can accomplish. Let them rise early and retire early to rest, and trust that their beauty will not need to be coined into artificial smiles, in order to secure a welcome, whatever room they enter. Let them ride, walk, run, dance, in the open air. Encourage the merry and innocent diversions in which the young delight; let them, under pro-

per guidance, explore every hill and valley; let them plant and cultivate the garden, and make hay when the summer sun shines, and surmount all dread of a shower of rain or the boisterous wind; and, above all, let them take no medicine except when the doctor orders it. The demons of hysteria and melancholy might hover over a group of young ladies so brought up, but they would not find one of them upon whom they could exercise any power.—[For. Quar. Review.]

Account of a Library for Working Men.—A correspondent, who gives his name and address, has been induced, by our notice of Sir J. Herschell's Address to the subscribers of the Windsor and Eton Public Library, (see p. 245, vol. ii. of this Magazine,) to send us an account of a similar institution on the Borders, with which he had been himself connected. He states that a gentleman, well known for his enlarged views of the state and prospects of society, being one evening in the place, was led to inquire whether there was any public library in the town. He was informed in reply, that there was one of ample extent, the entrance-money to which was £5, and the annual payment 14s. Feeling this to be beyond the reach of the poor, he inquired if there was no other library. He was told that there was the "Tradesman's Library," the entrance to which was £1, and the yearly payment 4s. This was nearer the point certainly, but still did not exactly meet the views from which this gentleman's inquiries had proceeded. "It will not supply the young," was his reply; "you must try another, to excite the desire of knowledge among the young and the poor." The minister of the parish, his lady, and a few other persons, adopted the suggestion. In a few days £20 were freely and readily given, and the donors were called to a meeting in the town-hall. At this meeting some were for allowing to the readers the gratuitous use of the books, but the majority very properly doubted the prudence of this plan, and it was decided to cherish the natural desire of independence in the poorest and youngest by requiring the payment of a penny monthly. It was also agreed that the volumes should be of small extent, that they might be returned once a month or oftener. The sum raised procured about eighty volumes, and a donation from the first mover of the plan added twenty or thirty more. The second week after the commencement there were above one hundred applicants, of whom about thirty were poor laborers or solitary females, and a larger number were under fourteen years of age. Numbers of them had not read two hours in succession for many years before. At the beginning of the second year the readers were allowed, at their own desire, to pay for six months at once, instead of a penny monthly. Our correspondent relates the following anecdote, which illustrates the useful effect of such institutions upon those for whose benefit they are intended.

In the following spring, when the days were lengthened, one of the readers, an agricultural laborer, came with the book he had been using, and declined to take another. He stated that, laboring at a distance for so many hours, he should not be able, during the summer, to indulge his desire for more reading. On being asked if he thought his monthly penny had been well spent, his hard countenance assumed the air of one who had found a treasure as he replied—"Had I paid you a shilling a week instead of a monthly penny, myself and family would have been gainers. During the winter months I and those like me got home and took dinner between four and five o'clock. Then an ill-ordered house and noisy family induced me and others to go out. If the weather was favorable, we stood to talk and spend an hour at the Cross; if otherwise, we went into a smithy for shelter, and often to the public-house, and, though I am not given to drink, yet we had to spend a little when there, and even a little frequently occurring is felt by a poor man. When I took home my first book from the library I was asked to read aloud, but objected because of the noisy children. After some time, the younger were put to sleep, and I began to read. Next morning, and every evening after, my house was clean and in order, the fireside trimmed, my meal waiting, the children in bed, or allowed to sit up on condition of listening as quietly as their attentive mother. The book we obtained from the library was Goldsmith's 'Animated Nature,' and it has been highly interesting to us. And, Sir, apart from all we have learned by reading, to find, week after week, my own house the most comfortable, and my own family the happiest, I ever saw, shows me that a poor man with his book in his hand may be as happy as the richest or most noble." This man concluded with assuring our correspondent that he had heard from others statements similar to that which he had made for himself.

Animal Mechanics, or Proofs of Design in the Animal Frame. [From the Library of Useful Knowledge.]

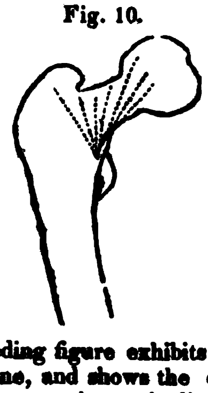
(Continued from page 115.)

Consider two men wrestling together, and then think how various the property of resistances must be: here they are pulling, and the bones are like ropes; or again, they are writhing and twisting, and the bones bear a force like the axle-tree between two wheels; or they are like a pillar under a great weight; or they are acting as a lever.

To withstand these different shocks, a bone consists of three parts, the *earth* of bone (sub-phosphate of lime); *fibres* to give it toughness; and *cartilage* to give it elasticity. These ingredients are not uniformly mixed up in all bones; but some bones are hard, from the prevalence of the earth of bone; some more fibrous, to resist a pull upon them; and some more elastic, to resist the shocks in walking, leaping, &c. But to return to the forms. Whilst the centre of the long bones is, as we have stated, cylin-

drical, their extremities are expanded, and assume various shapes. The expansion of the head of the bone is to give a greater, and consequently a more secure surface for the joint, and its form regulates the direction in which the joint is to move. A jockey, putting his hand on the knee of a colt, and finding it broad and flat, augurs the perfection of the full-grown horse. To admit of this enlargement and difference of form, a change in the internal structure of the bone is necessary, and the hollow of the tube is filled up with *cancelli*, or lattice work. These *cancelli* of the bone are minute and delicate-like wires, which form lattice-work, extending in all directions through the interior of the bone, and which, were it elastic, would be like a sponge. This more uniform texture of the bone permits the outer shell to be very thin, so that whilst the centre of the long bones are cylinders, their extremities are of a uniform cancellated structure. But it is pertinent to our purpose to notice, that this minute lattice work, or the cancelli which constitute the interior structure of bone, have still reference to the forces acting on the bone; if any one doubts this, let him make a section of the upper and lower end of the thigh bone, and let him inquire what is the meaning of the difference in the *lie* of these minute bony fibres, in the two extremities? He will find that the head of the thigh bone stands obliquely off from the shaft, and that the whole weight bears on what is termed the *inner trochanter;* and to that point, as to a buttress, all these delicate fibres converge, or point from the head and neck of the bone, which may be rudely represented in this way.

Fig. 10.



The preceding figure exhibits the head of the thigh bone, and shows the direction of the *cancelli*, converging to the line of gravity.

We may here notice an opinion that has been entertained in regard to the size of animals. It is believed that the material of bone is not capable of supporting a creature larger than the elephant, or the *mastodon*, which is the name of an extinct animal of great size, the osseous remains of which are still found. This opinion is countenanced by observing that their bones are very clumsy, that their spines are of great thickness, and that their hollow cylinders are almost filled up with bone.

It may be illustrated in this manner: A soft stone projecting from a wall may make a stile strong enough to bear a person's weight; but if it were necessary to double its length, the thickness must be more than doubled, or a free-stone substituted; and were it necessary to make this free-stone project twice as far from the wall, even it doubled in thickness, it would not be strong enough to bear a proportioned increase of weight: granite must be placed in its stead; and even the granite would not be capable of sustaining four times the weight which the soft stone bore in the first instance. In the same way the stones which form an arch of a large span must be of the hardest granite, or their own weight would crush them. The same principle is applicable to the bones of animals. The material of bone is too soft to admit an indefinite increase of weight; and it is another illustration of what was before stated, that there is a relation established through all nature, and that the very animals which move upon the surface of the earth are proportioned *to its magnitude*, and the gravitation to its centre. Archdeacon Paley has with great propriety taken the instance of the form of the ends of bones, as proving design in the mechanism of a joint. But there is something so highly interesting in the conformation of the whole skeleton of an animal, and the adaptation of any one part to all the other parts, that we must not let our readers remain ignorant of the facts, or of the important conclusions drawn from them.

What we have to state has been the result of the studies of many naturalists; but although they have labored, as it were, in their own department of comparative anatomy, they have failed to seize upon it with the privilege of genius, and to handle it in the masterly manner of Cuvier.

Suppose a man ignorant of anatomy to pick up a bone in an unexplored country, he learns nothing excepting that some animals have lived and died there; but the anatomist can, by that single bone, estimate not merely the size of the animal, as well as if he saw the print of its foot, but the form and joints of the skeleton, the structure of its jaws and teeth, the nature of its food, and its internal economy. This, to one ignorant of the subject, must appear wonderful, but it is after this manner that the anatomist proceeds. Let us suppose that he has taken

up that portion of bone in the limb of the quadruped which corresponds to the human wrist; and that he finds that the form of the bone does not admit of free motion in various directions, like the paw of the carnivorous creature. It is obvious by the structure of the part, that the limb must have been merely for supporting the animal, and for progression, and not for seizing prey. This leads him to the fact that there were no bones resembling those of the hand and fingers, or those of the claws of the tiger; for the motions which that conformation of bones permits in the paw would be useless without the rotation of the wrist—he concludes that these bones were formed in one mass, like the cannon bone, pastern-bone, and coffin-bones of the horse's foot.*

The motion limited to flexion and extension of the foot of a hoofed animal implies the absence of a collar bone and a restrained motion in the shoulder joint; and thus the naturalist, from the specimen in his hand, has got a perfect notion of all the bones of the anterior extremity! The motions of the extremities imply a condition of the spine which unites them. Each bone of the spine will have that form which permits the bounding of the stag, or the galloping of the horse, but it will not have that form of joining which admits the turning or writhing of the spine, as in the leopard or the tiger.

And now he comes to the head: the teeth of a carnivorous animal, he says, would be useless to rend prey unless there were claws to hold it, and a mobility of the extremities like the hand to grasp it. He considers, therefore, that the teeth must have been for bruising herbs, and the back teeth for grinding. The socketing of these teeth in the jaw gives a peculiar form to these bones, and the muscles which move them are also peculiar; in short, he forms a conception of the shape of the skull. From this point he may set out anew, for by the form of the teeth he ascertains the nature of the stomach, the length of the intestines, and all the peculiarities which mark a vegetable feeder.

Thus the whole parts of the animal system are so connected with one another, that from one single bone or fragment of bone, be it of the jaw, or of the spine, or of the extremity, a really accurate conception of the shape, motions, and habits of the animal may be formed.

It will readily be understood that the same process of reasoning will ascertain, from a small portion of a skeleton, the existence of a carnivorous animal, or of a fowl or of a bat, or of a lizard, or of a fish; and what a conviction is here brought home to us, of the extent of that plan which adapts the members of every creature to its proper office, and yet exhibits a system extending through the whole range of animated beings, whose motions are conducted by the operation of muscles and bones.

After all, this is but a part of the wonders disclosed through the knowledge of a thing so despised as a fragment of bone. It carries us into another science; since the knowledge of the skeleton not only teaches us the classification of creatures now alive, but affords proofs of the former existence of animated beings which are not now to be found on the surface of the earth. We are thus led to an unexpected conclusion from such premises: not merely the existence of an individual animal, or race of animals, but even the changes which the globe itself has undergone in times before all existing records, and before the creation of human beings to inhabit the earth, are opened to our contemplation.

Of Standing.—This may appear to some a very simple inquiry, and yet it is very ignorant to suppose it is so. The subject has been introduced in this fashion: "Observe these men engaged in raising a statue to its pedestal with the contrivances of pullies and levers, and how they have placed it on the pedestal and are soldering it to keep it steady, lest the wind should blow it down. This statue has the fair and perfect proportions of the human body; to all outward appearance it ought to stand."

In the following passage we have the same idea thrown out, in a manner which we are apt to call *French*. Were a man cast on a desert shore, and there to find a beautiful statue of marble, he would naturally exclaim, "Without doubt there have been inhabitants here: I recognize the hand of a famous sculptor: I admire the delicacy with which he has proportioned all the members of the body, to give them beauty, grace, and majesty, to indicate the motion and expression of life." But it may be asked, what would such a man think if his companion were to say, "Not at all; no sculptor made this statue; it is formed, to be sure, in the best taste, and according to the rules of art, but it is formed by chance. Amongst the many fragments of marble there has been one thus formed of itself. The rain and the winds have detached it from the mountain,

* For these are solid bones, where it is difficult to recognize any resemblance to the carpus, metacarpus, and bones of the fingers; and yet comparative anatomy proves that these moveable bones are of the same class with those in the solid hoof of the *belluæ* of Linnæus.

and a storm has placed it upright on the pedestal. The pedestal, too, was prepared of itself in this lonely place. True, it is like the Apollo, or the Venus, or the Hercules. You might believe that the figure lived and thought; that it was prepared to move and speak; but it owes nothing to art—blind chance has placed it there."*

The first passage suggests the conviction, that the power of standing proceeds not from any symmetry, as in a pillar, or from gravitation alone. It, in fact, proceeds from an internal provision, by which a man is capable of estimating with great precision the inclination of his body, and correcting the bias by the adjustment of the muscles. In the second passage, it is meant to be shown that the outward proportion of the form bears a relation to the internal structure; that grace and expression are not superficial qualities, and that only the Divine Architect could form such a combination of animated machinery.

We shall consider how the human body is prepared by mechanical contrivances to stand upright, and by what fine sense of the gravitation of the body the muscles are excited to stiffen the otherwise loose joints, and to poise the body on its base.

Of the Foot.—Let us take the arrangement of the bones of the foot, according to the demonstration of the anatomists.

They are divided into the *tarsus*, which is composed of seven bones, reaching from the heel to the middle of the foot. The *metatarsus*, which consists of five long bones laid parallel to each other, and extending from the *tarsus* to the roots of the toes. The bones of the toes are called *phalanges*, from being in the form of a *phalanx*.

There are in all thirty-six bones in the foot; and the first question that naturally arises is, why should there be so many bones? The answer is, In order that there may be so many joints; for the structure of a joint not only permits motion, but bestows elasticity.

A joint, then, consists of the union of two bones, of such a form as to permit the necessary motion, but they are not in contact; each articulating surface is covered with cartilage, to prevent the jar which would result from the contact of the bones. This cartilage is elastic, and the celebrated Dr. Hunter discovered that the elasticity was in consequence of a number of filaments closely compacted, and extending from the surface of the bone, so that each filament is perpendicular to the pressure made upon it. The surface of the articulating cartilage is perfectly smooth, and is lubricated by a fluid called *synovia*, signifying a mucilage, a viscous or thick liquor. This is vulgarly called *joint oil*, but it has no property of oil, although it is better calculated than any oil to lubricate the interior of the joint.

When inflammation comes upon a joint, this fluid is not supplied and the joint is stiff, and the surfaces creak upon one another like a hinge without oil. A delicate membrane extends from bone to bone, confining this lubricating fluid, and forming the boundary of what is termed the cavity of the joint, although, in fact, there is no unoccupied space. External to this capsule* of the joint, there are strong ligaments going from point to point of the bones, and so ordered as to bind them together without preventing their proper motions. From this description of a single joint, we can easily conceive what a spring or elasticity is given to the foot, where thirty-six bones are jointed together.

An elegant author has this very natural remark on the joints: "In considering the joints, there is nothing perhaps which ought to move our gratitude more than the reflection, *how well they wear*. A limb shall swing upon its hinge, or play in its socket, many hundred times in an hour, for sixty years together, without diminution of its agility, which is a long time for any thing to last, for any thing so much worked and exercised as the joints are. This durability I should attribute, in part, to the provision which is made for the preventing of wear and tear: first, by the polish of cartilaginous surfaces; secondly, by the healing lubrication of the mucilage; and in part to that astonishing property of animal constitutions, assimilation, by which, in every portion of the body, let it consist of what it will, substance is restored and waste repaired."—[Paley.]

If the ingenious author's mind had been professionally called to contemplate this subject, he would have found another explanation. There is no resemblance betwixt the provisions against the wear and tear of machinery and those for the preservation of a living part. As the structure of the parts is originally perfected by the action of the vessels, the function or operation of the part is made the stimulus to those vessels. The cuticle on the hands wears away like a glove; but the pressure stimulates the living surface to force successive layers of skin under that which is wearing, or, as the anatomists call it, disquamating, by which they mean that the cuticle does not change at once, but comes off in *squamæ*, or scales.

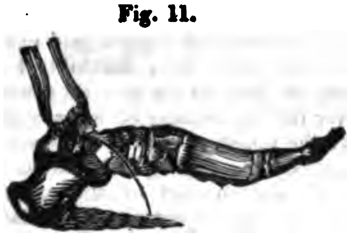
* Demonstration de l'Existence de Dieu, par Fenelon.

* From *capsula*, a little case or box.

The teeth are subject to pressure in chewing or masticating, and they would by this action have been driven deeper in the jaw, and rendered useless, had there not been a provision against this mechanical effect. This provision is a disposition to grow, or rather to shoot out of their sockets; and this disposition to project, balances the pressure which they sustain; and when one tooth is lost, its opposite rises, and is in danger of being lost also, for want of that very opposition.

The most obvious proof of contrivance is the junction of the foot to the bones of the leg at the ankle joint. The two bones of the leg, called the *tibia* and the *fibula*, receive the great articulating bone of the foot (the *astragalus*) betwixt them. And the extremities of these bones of the leg project so as to form the outer and inner ankle. Now, when we step forward, and whilst the foot is raised, it rolls easily upon the ends of these bones, so that the toe may be directed according to the inequalities of the ground we are to tread upon; but when the foot is planted, and the body is carried forward perpendicularly over the foot, the joint of the leg and foot becomes fixed, and we have a steady base to rest upon. We next observe that, in walking, the heel first touches the

Fig. 11.



ground. If the bones of the leg were perpendicular over the part which first touches the ground, we should come down with a sudden jolt, instead of which we descend in a semi-circle, the centre of which is the point of the heel.

And when the toes have come to the ground, we are far from losing the advantages of the structure of the foot, since we stand upon an elastic arch, the hinder extremity of which is the heel, and the anterior the balls of the toes. A finely formed foot should be high in the instep. The walk of opera dancers is neither natural nor beautiful; but the surprising exercises which they perform give to the joints of the foot a freedom of motion almost like that of the hand. We have seen the dancers in their morning exercises stand for twenty minutes on the extremities of their toes, after which the effort is to bend the inner ankle down to the floor, in preparation for the Bolero step. By such unnatural postures and exercises the foot is made unfit for walking, as may be observed in any of the retired dancers and old *figurantes*. By standing so much upon the toes, the human foot is converted to something more resembling that of a quadruped, where the heel never reaches the ground, and where the paw is nothing more than the phalanges of the toes. This arch of the foot, from the

Fig. 12.

heel to the toe, has the astragalus, A, resembling the key-stone of an arch; but, instead of being fixed, as in masonry, it plays freely betwixt two bones, and from these two bones, B and C, a strong elastic ligament is extended, on which the bone A rests, sinking or rising as the weight of the body bears upon it, or is taken off, and this it is enabled to do by the action of the ligament which runs under it.

This is the same elastic ligament which runs extensively along the back of the horse's hind leg and foot, and gives the fine spring to it, but which is sometimes ruptured by the exertion of the animal in a leap, producing irrecoverable lameness.

Having understood that the arch of the foot is perfect from the heel to the toe, we have next to observe that there is an arch from side to side; for when a traverse section is made of the bones of the foot, the exposed surface presents a perfect arch of wedges, regularly formed like the stones of an arch in masonry. If we look down upon the bones of the foot, we shall see that they form a complete circle horizontally, leaving a space in their centre. These bones thus form three different arches—forward, across, and horizontally; they are wedged together, and bound by ligaments, and this is what we alluded to when we said that the foundations of the Eddystone were not laid on a better principle; but our admiration is more excited in observing that the bones of the foot are not only wedged together, like the courses of stone for resistance, but that solidity is combined with elasticity and lightness.

Notwithstanding the mobility of the foot in some positions, yet, when the weight of the body bears directly over it, it becomes immoveable, and the bones of the leg must be fractured before the foot yields.

We shall proceed to explain how the knee joint and hip joint, independently of the exertion of muscles, become firm in the standing position, and when at rest; but before we enter upon this, let us understand the much-talked-of demonstration of Borelli, who explained the manner in which a bird sits upon a branch when asleep. The weight of the creature and the consequent flexion of the limbs drawing the tendons of the talons so as to make them grasp the branch without muscular effort.

Fig. 13.

The muscle A passing over the joint at B, and then proceeding to the back of the leg, and behind the joint at C, and so descending behind the foot at D, it extends to the talons; and the weight of the bird bending the join' B and C, produces the effect of muscular effort, and makes the claws cling.

But why should the anatomist have recourse to this piece of comparative anatomy, when he has so fine an example in the human body? And one which is much more interesting, as, in fact, it is the foundation of reasoning upon the diseases and accidents of the limb. If this beautiful arrangement in the healthy and perfect structure of a man's limb be not attended to, it would be easy to prove that many important circumstances in regard to disease and accidents must remain obscure.

The posture of a soldier under arms, when his heels are close together and his knees straight, is a condition of painful restraint. Observe, then, the change in the body and limbs, when he is ordered to stand at ease; the firelock falls against his relaxed arms, the right knee is thrown out, and the tension of the ankle joint of the same leg is relieved, whilst he loses an inch and a half of his height, and sinks down upon his left hip. This command to "stand at ease" has a higher authority than the general orders. It is a natural relaxation of all the muscles, which are consequently relieved from a painful state of exertion: and the weight of the body bears so upon the lower extremity, as to support the joints independently of muscular effort. The advantage of this will be understood when we consider that all muscular effort is made at the expense of a living power, which, if excessive, will exhaust and weary a man, whilst the position of rest which we are describing is without effort, and therefore gives perfect relief. And it is this which makes boys and girls, who are out of health and languid, lounge too much in the position of relief, from whence comes permanent distortion. This figure represents the bones of the leg.

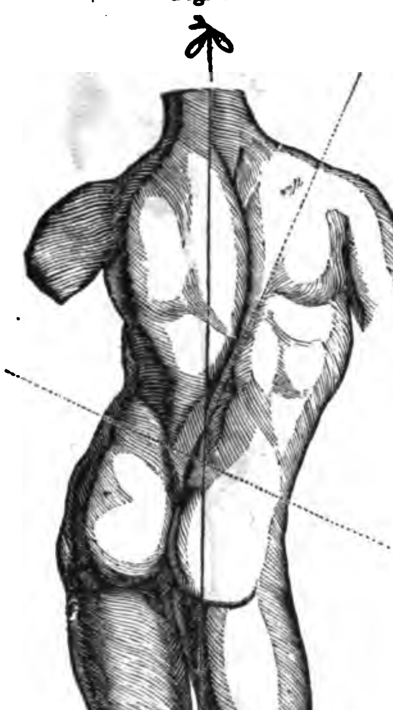
Fig. 14.

The plumb line shows the direction of the gravitation of the body falling behind the head of the thigh bone. Now, if it be understood that the motions of the trunk are performed on the centre of the head of the

thigh bone, it must follow that the weight of the body in the direction of the plumb line must raise the corner of the haunch bone, at A. From this corner of the bone, a broad and strong band runs down to the knee-pan, B, in the direction of the dotted line. The powerful muscles which extend the leg are attached to the knee-pan, and, through the ligament at C, operate on the bones of the leg, stretching them and preventing the flexion of the joint; but, in the absence of the activity of these muscles, the band reaching from A to B, drawn, as we have said, by the weight of the body, is equivalent to the exertion of the muscles, braces the knee joint, and extends the leg; and we have before seen that the extension of the leg fixes the ankle joint. Thus the limb is made a firm pillar under the weight of the body, without muscular effort.

When the human figure is left to its natural attitudes, we see a variety and contrast in the position of the trunk and limbs.

Fig. 15.



This position of the body resting on the lower extremities throws the trunk into an elegant line, and places the limbs in beautiful contrast, as we see in all the best specimens of sculpture.

Now, that we have understood that the lower extremity becomes in some positions a firm pillar, it is the more necessary to observe the particular form of the head of the thigh bone.

Fig. 16.

It is here seen that the head of the bone A stands off from the shaft by the whole length of the neck of the bone B; the effect of this is, that, as the powerful muscles are attached to the knobs of bone, C, D, they turn the thigh bone round in walking with much greater power than if the head of the bone were on a line with the shaft. They, in fact, acquire a lever power by the distance of D from A, as, during the action of these muscles, the limb is stiff; the rolling of the thigh directs the toe outwards in walking.

When the weight of the body is perpendicular over the ball of the great toe, the whole body is twisted round on that point as on a pivot. This rolling of the body on the ball of the toe, and consequent turning out of the toes in stepping forward, is necessary to the freedom and elasticity of the motion. The form of all the bones of the leg, and the direction of all the muscles of the thigh and leg, combine to this effect. So far is it from being true, as painters affect to say, that the turning out of the toes is the result of the lessons of the dancing master.

A certain squareness in the position of the feet is consistent with strength, as we see in the statues of the Hercules, &c.; but the lightness of a Mercury is indicated by the direction of the toes outwards. In women there would be a defect from the breadth of the pelvis, and a rolling and an awkward

gait would be the consequence; but in them the foot is more turned out,, and a light elastic step balances the defect arising from the form of the pelvis. Any one may be convinced of this by observing people who walk awkwardly, especially if they walk unequally. Look at their feet, and you will see that one foot goes straight forward, whilst the other is turned outwards, and that when they come upon the straight foot, they come down awkwardly, and have no spring from it.

On the Architecture of the City of New-York. By ?. To the Editor of the Mechanics' Magazine.

Sir,—I have been in hopes that the very clever Alphabet of Architecture, which has appeared from time to time in your useful Magazine, would have induced some *original* communications upon this one of the most interesting and ornamental of the fine arts, and one which we must acknowledge with regret has been too little cultivated in our good city. To which of our public buildings can we point with any feeling of pleasure and pride? We have a few, it is true, in which the designs are good as far as they go; but there are in all some things to offend: one is too diminutive; in another the material is of an inferior kind; a third is deformed by the addition of some *fandangle* or other, entirely foreign to the style, after it is supposed to be completed; in short, a correct eye cannot rest with satisfaction upon any one of the *fancy fabrics* with which New-York abounds. To instance a few, let us take a stroll up Wall street. The Exchange first arrests our eye, and is remarkable, I believe, for nothing but its columns, each shaft being a single block, and weighing some 25 tons and upwards. I suppose it answers every purpose of an Exchange, but we can say nothing further in its favor. We are next attracted by the Phenix and National Banks, both well designed, but entirely too small. They seem as if intended rather as samples of the Sing-Sing marble than to answer any useful purpose. Next we have the United States Branch Bank, City Bank, &c.: all flat unmeaning piles of stone and mortar. Turning into Broadway, the City Hall is not without claims to our attention; and considering the date of its construction, and the perfect youthfulness of the art with us at that period, I am far from condemning it *in toto*, as some have done, because, perhaps, the windows may be too numerous, and the cupola too small; the attic story, however, I must confess to be in very bad taste; but the rotunda is a redeeming feature in the building, and has been very deservedly admired. The Hall of Record, on the left, is patched up, perhaps as well as could have been expected; but who could transform a Dutch jail into a Grecian temple? No less a person, certainly, than the chairman of the Committee on Arts and Sciences of the Board of Aldermen of the city of New-York. As we proceed up Broadway we pass a large flat dirty-looking structure, known as the Masonic Hall, and upon which money enough was expended to produce something ornamental to the city; but such a presumptuous idea seems not to have entered into the calculations of the architect. As we advance we must not forget the French Church, a step or two out of our way, in Franklin street, which bids fair to be a well proportioned classical edifice, and, with the exception of the choice of material, reflecting credit upon the architect and the Society. Returning to Broadway, after another mile of little interest, we find ourselves opposite to St. Thomas' Church: to speak correctly, the only specimen of Gothic architecture we possess, the Cathedral being in an unfinished state, (which is to be regretted, as the interior is in a very good style.) This building, with all its arches and tracery, and painted glass, and gloom, is, after all, (I refer to the interior more particularly,) but a pretty piece of fancy work. The architect has allowed his imagination too much range, and committed many faults, which are, however, easily pardoned, when we consider that it is the pioneer of its style in our city. The effect from the street is good, and taken as a whole should be respected. We are now in the upper part of the city, and it is but a step to Lafayette Place; and here we cannot but regret the taste which could think of accommodating a Corinthian colonnade to a row of dwelling houses. No fault can be found with the colonade itself (I do not speak of the basement); the columns are, I dare say, exactly nine and a half modules, according to Palladio, and the members in their proper proportion; but I blame the want of fitness in the arrangement. It is not calculated to answer the proposed end, the principal rooms being badly lighted, and the building not sufficiently disconnected.

There are other works, both public and private, not without merit, but I have confined myself to the most attractive; and if my observations have any virtue in them, I need hardly repeat my first remark, that architecture has been too much neglected in our city. But let us hope that this reproach will not always be cast upon her. In the

erection of the new Custom House an opportunity is offered to redeem herself in the eyes of her sister cities; for, although a Government building, and independent of our municipal authorities, still it must owe its elegance or deformity to the taste, or want of it, of our own citizens and architects, Messrs. Town and Davis; and that it *will* be an ornament to our city, no one can doubt after having seen the elevation and section as exhibited in the American Academy. It is enough in this place to say of it, that it is in a pure classical style, and without any claim to originality—a deficiency, I think, very much in its favor. One thing I rejoice at: the architects have received, I am well informed, positive assurance from the Secretary that they shall be permitted to "*follow their own plan*, without being subject to the revision of any committee or sub-committee." It is well known to what annoyance artists are subject from the impertinent interference of some people in such situations of petty authority, who seem to imagine them mere tools, and with no right to a will of their own. In time, however, these difficulties will disappear, and with the general diffusion of correct taste, men of real talent, whether artists, mechanics, or tradesmen, will find their proper level in society.

The Philosopher of Bologna unmasked; or Galvani not the Discoverer of Galvanism. By R. W. Dickinson. [From the London Mechanics' Magazine.]

Sir,—It appears to me very singular that no notice should ever have been taken of an experiment made by M. Du Verney, before the Fellows of the Royal Academy at Paris, in the year 1700, and published by their secretary, the celebrated M. Fontenelle, in his Account of the Transactions of the Society for that year. It is there related that M. Du Verney exhibited a dead frog, and on irritating it *with a scalpel* the nerves of the belly, that led to the thighs and legs, trembled and suffered a sort of convulsion. He afterwards cut the nerves in the belly, and stretching them with his hands, a similar convulsion was produced *by the application of the scalpel.* Now, though it may at this distance of time be impossible to adduce positive proof that Galvani was acquainted with this previous experiment of M. Du Verney, I cannot help thinking that it is *quite as likely* he was so, as that he should have come to a knowledge of the fact in the strange way he pretended, namely, through one of his pupils accidentally touching *with a scalpel* the crural nerve of a frog, which was being prepared in the laboratory of the professor, to make a soup for his sick wife. That a *frog* should have been the animal operated upon in both instances, and a *scalpel* the operating instrument, are coincidences pregnant with suspicion. At all events, this much cannot be disputed, that the Bolognese philosopher did at least only discover what Verney had discovered and made known to the world long before; though there is now, probably, as little chance of our seeing the name of *Verneyism* substituted for *Galvanism*, as *Columbia* for *America.*

I am, sir, yours sincerely,

R. W. Dickinson.

Ilfracombe, Dec. 16, 1833.

A Compendium of Civil Architecture, arranged in Questions and Answers, with Notes, embracing History, the Classics, and the Early Arts, &c. By Robert Brindley, Architect, Surveyor, and Engineer. [Continued from page 85.]

SARACENIC. A. D. 410.

Q. What is said of the Saracenic style of architecture, considered as the immediate precursor to the Gothic?

A. This style, partaking of very little of the aboriginal inhabitants, is distinguished by the lofty boldness of its vaulting, the slenderness of its columns, the peculiar mixed form of its curves, the variety of its capitals, and the immense profusion of its ornaments.

Q. Where is the greatest peculiarity of this style?

A. In its small clustered pillars and pointed arches, formed by the segments of two intersecting circles.

Q. What is the difference between the Egyptian Saracenic and the Spanish Saracenic?

A. Chiefly in the form of the arch; held in comparison by the gate of Cairo, with that of the Alhambru in Granada, and the great church at Cordova.

GOTHIC. A. D. 408.

Q. What is the style of the Gothic architecture?

A. It is grand, characteristic, and impressive, having a peculiarity of claim.

Q. What are the elements of this style?

A. Spires, pinnacles, and lofty pointed windows, derived from its type, the pyramid or cone. Thus Mr. Elmes observes, "all we see in it is pyramidical; its shafts shoot upwards; its arches are shaped like points of lancets; its windows form themselves into pyramidical tracery; and it has not been inaptly compared to groves of trees."

Q. Where are the principal Gothic edifices erected?

A. In the North and West of Europe.

Q. Commencing with Britain, as now partaking of the rudiments of architecture, A. D. 460, how may the variations be delineated?

A. The first epoch of time comprises that space of time between Augustan Excellence and the total expulsion of the Romans, 450.

Q. The second epoch?

A. This commences with the introduction of the Saxon style.

Q. The third epoch?

A. This commences with that of the English, including all its varieties, from the plainness of the Norman to the meretricious enrichments of the florid.

Q. The fourth epoch?

A. That of the Grecian and Roman orders.

Q. What was the condition of the aboriginal Britons?

A. That of barbarism; and their architecture was no less so; for, "The Britons," says Diodorus Siculus, who was contemporary with Cæsar, "dwell in wretched cottages, constructed of wood, and covered with straw. These wooden houses were not square, but circular, with high tapering roofs, having an aperture at the top for the admission of light, and the emission of smoke."

Q. How were their Druidical temples constructed?

A. They consisted of ranges of unhewn stone, enclosing a circular area; their only covering being the canopy of heaven.

Q. Did the Romans introduce their own architecture?

A. Yes, in some degree; of which a variety of specimens have been found, and some few still remain, such as the ramparts on the great Roman road (North of England); several altars and sepulchres, as discovered on Chatham hill, Kent, and at York. The gate of Lincoln is also a fine specimen, the only one retaining its original use.

Q. After the Romans left England, what was the state of architecture.

A. It declined rapidly; their numerous architects being called to the building of Constantinople; and the people left behind having neither skill nor courage to defend themselves from the Anglo-Saxons, every thing fell by their barbarous hands, destroying towers and castles instead of preserving them. Indeed, they knew nothing of the fine arts or architecture for nearly two hundred years after their arrival.

SAXON. 600 A. D.

Q. How is the progress of Saxon architecture described, as noticed principally in ecclesiastical edifices?

A. First, the *early Saxon* or *dawning Saxon*, continued from the conversion of Egbert, King of Kent, about A. D. 598, and from the first building of Archbishop Theodore's churches to the time of King Alfred, about A. D. 872.

Q. What is the criterion distinguishing this era?

A. The *multitude* of the minute and *designedly varied* ornaments of the several parts. A characteristic specimen may be seen in Barefreston church, in Kent.

Q. What is the second description?

A. The *full Saxon*, or *perfect Saxon*, continued from Alfred to Canute, and the time of the first Harold, about 1036.

Q. What is the criterion?

A. The style appears to be more bold and noble, with less numerous ornaments, but still with much variety in the adornments. The cathedral of Christ Church, Oxford, and Canute's gate, at St. Edmund's Bury, Suffolk, afford illustrations.

Q. What is the third era?

A. The *declining Saxon*, liable to be confounded with the Norman; which species of architecture continued from Canute to the conquest.

Q. What are the distinguishing marks?

A. Its clumsy stately magnificence, on a greater scale, and in greater proportions; and by its having cast off so much of its varied ornaments, being difficult to be distinguished from the first style of the Norman.

Q. Where are specimens of the style?

A. At Southwell and Waltham.

DANES. 819 A. D.

Q. What of Danish architecture?

A. It can only be conjectural, from the limited power and pagan disposition of the people.

Q. What specimens does tradition hand down as the work of their hands?

A. The round towers attached to several English parochial churches in Norfolk and Suffolk; but from the rudeness of the works, they are of very remote date. And the conclusion is, that they destroyed rather than built, but in time adopted the architectural fashions of the Anglo-Saxons, as as well as their religion.

Q. What was the result of the Norman conquest?

A. The introduction of a new species of architecture, which may be divided into *four* distinct periods or styles: 1st, Norman style; 2d, early English; 3d, decorated English; 4th, perpendicular English.

Q. To what are these styles to be confined, as affording any criterion for dissertation?

A. Almost wholly to churches. Castella-

ted buildings being so metamorphosed, from the different modes of warfare, as to leave no testing proof of their originality.

Q. What is to be understood by the appellation *style*?

A. The composition of the whole building.

Q. How were the ancient ecclesiastical edifices built?

A. Generally in the form of a cross, with a tower, lantern, or spire, erected at the intersection.

Q. How was the interior divided?

A. Thus: 1st, the space westward of the cross into the *nave*, or as rendered in the Latin, "ampli interioris templi pars;" 2d, the space eastward of the cross—the *choir*; 3d, the parts north and south—the *transepts*; 4th, the divisions outward of the piers—the *aisles*.

Q. Where is the *choir*?

A. In the western part, where the organ is, and generally enclosed by a screen. In cathedrals it does not extend to the eastern end of the building, as there is a space behind the altar usually called the *Lady Chapel*;* and furthermore, it is only between the piers, and does not include the *aisles*, which are passages. Sometimes the choir advances west of the cross, as at Westminster.

Q. How describe the *transepts*?

A. They have side aisles, which are often separated by screens for chapels.

Q. What are *chapels*?

A. They are additional buildings distributed throughout.

Q. What and where is the *triforium*?

A. It is a gallery between the arches of the nave and the clerestory windows.

Q. Where is the *chancel*?

A. In churches not collegiate, it is the eastern space about the altar.

Q. What are the *porches*?

A. Small buildings attached to the sides of the main body at the doors, over which are schools, vestries, &c.

Q. What is the *font*?

A. A large stone basin supported by a pedestal; and generally in large churches is placed in the western nave.

Q. Where are the principal entrance doors?

A. In large churches they are generally at the west end, or end of transepts, or both; in small churches at the sides.

Q. What other buildings are attached to most cathedrals?

A. A *Chapter House*—often multangular; and *cloisters* (usually on the same side) forming a quadrangle, with an open space in the centre—the sides of which are a series of open arches. The other wall is the side of the church, or other buildings, with which the cloisters communicate by sundry doors. The cloisters are arched over, and form the principal communication between the different parts of the monastery.

Q. What are the spaces between the windows or apertures termed?

A. *Piers*.

Q. What are the windows above the arches, on the outside, over the top of the aisles, called?

A. *Clerestory windows*.

Q. What are the buildings above the roof designated?

A. *Steeples*; if square topped, *towers*; which may be square, multangular, or round; these are frequently surmounted by *spires*, of conical form, and sometimes a short tower of light work, termed a *lantern*.

Q. What are towers of greater height, in proportion to their diameters, named?

A. *Turrets*. These sometimes have small spires. Large towers often have turrets at their angles.

Q. What are *buttresses*?

A. Projections between the apertures, or at the angles of towers, worked in stages, to strengthen the adjacent parts.

Q. How are the walls crowned?

A. By *parapets*, which are straight at the top, or *battlements*, indented.

Q. What are *arches*?

A. They are either round, pointed, or mixed.

Q. Whence their origin?

A. That of the round is from the Romans; the pointed is of Arabian extraction, introduced by the Crusaders, on returning from the Holy Land; and the mixture is that of English device.

Q. What are *piers*?

A. Columns on shafts, of different sizes and shapes, supporting the several arches.

Q. How many arches are there described?

A. Eight.

Q. What is the first?

A. A *semi-circular arch*, having its centre in the same line with the spring.

Q. What is the second?

A. A *segmental arch*, with the centre lower than the spring.

Q. What is the third?

A. An *equilateral arch*, described from two centres.

Q. What is the fourth?

A. A *drop arch*, which has a radius shorter than the breadth of the arch, and is described about an obtuse angled triangle.

* The Lady Chapel is not always at the east end of the choir. At Durham it is at the west end of the nave; at Ely, on the north side.

Q. What is the fifth?

A. The *lancet arch*, which has a radius longer than the breadth of the arch, and is described about an acute angled triangle.

Q. What is the sixth?

A. The *horse-shoe arch*, which has the centre above the spring.

Q. What is the seventh?

A. The *ogee*, or *concentrated arch*, which has four centres; two in or near the span, and two above it reversed.

Q. What is the eighth?

A. The *tudor arch*. This is flat for its span; has two of its centres in or near the spring, and two considerably below it.

Q. What is the space included between the arch and a square formed outside called?

A. The *spandrill*.

Q. How are windows divided?

A. Perpendicularly by *mullions*, and horizontally by *transoms;* the ornaments at the head into *tracery*, either *flowing* or *perpendicular*.

Q. How are the several parts of the tracery ornamented?

A. With small arches and points termed *feathering*, or *foliation*.

Q. How are small arches ornamented?

A. By *cusps*, enumerated as trefoil, quatrefoil, and cinquefoil, &c. These *cusps* are again feathered, called double feathering.

Q. What are *tablets?*

A. Small projecting mouldings. That at the top, under the battlements, as a *cornice*; that running round doors and windows, the *dripstone*; and if ornamented, a *canopy*.

Q. What are *bands?*

A. Small strings round shafts.

Q. What are *niches?*

A. Small arches sunk in walls, often ornamented, and into which figures are introduced.

Q. What is a *corbel?*

A. A projection from the wall, supporting an arch or a pier.

Q. What is a *pinnacle?*

A. A small spire.

Q. What are *canopies?*

A. Projections surmounting doors, niches, thrones, &c. and beautifully ornamented.

Q. What are the several bunches of foliage on canopies designated?

A. The small, *crockets;* the large, *finials*. These ornaments are also used on pinnacles.

Q. What are the seats for the Dean, Canons, &c. in choirs of collegiate churches, named?

A. *Stalls*.

Q. What is the Bishop's seat called?

A. The *throne*, exceedingly ornamented, with canopy, &c.

Q. As what is the ornamental work over *stalls* known?

A. *Tabernacle work*.

Q. What is the *stoupe?*

A. A basin, containing holy water, placed in a niche near the entrance.

Q. Where is the *rood loft?*

A. In churches, not collegiate, it is a space screened off between the nave and chancel, and which, formerly, contained images.

Q. Where and what is the *piscena?*

A. It is in a niche, near to the altar, distinguished from the stoupe by having a small hole at the bottom, to carry off the remains of the consecrated wine. It is often double, having a place for the bread.

Q. What are *crypts?*

A. Vaulted chapels in the foundations, used for burial places.

Ericsson's Caloric Engine. [From the London Mechanics' Magazine.]

Sir,—A critical notice, or review, of the principle of the Caloric Engine, as described in the short pamphlet from which you made some extracts in a recent number of your Journal, having made its appearance in the *Repertory of Patent Inventions* of this day, you will much oblige me by admitting the following remarks upon it into your columns:

I will follow the reviewer in the same order that he proceeds.

1st. I am reminded of "the Cornwall steam engines raising from 60 to 80,000,000 pounds one foot high by the consumption of a bushel of coals." In reply, I would advise the reviewer to make himself acquainted with the power produced by a *steam engine that consumes only* 10 *lbs. of fuel per hour*. This, I think, will be his best guide in comparing the effect of the trial engine with that of the steam engine; for I cannot help concluding, from the ignorance with which he has treated the subject, he would waste his time by entering into the philosophy of the two modes of producing motive power, in order to determine which of them is capable of producing the greatest effect by a given quantity of fuel.

2d. The reviewer cannot understand how any loss of heat can take place in the steam engine by the steam being condensed, and its heat imparted to the condensing water; but a few words, I think, will enlighten his mind on this most important point. The water used for condensing is usually about 50°, and the heat of the condenser about 120°; thus, the boiler will be fed with water at 70° higher temperature than if the boiler were *not supplied* from the condenser.

Now the latent heat of steam is 1000° ; hence the whole heat returned to the boiler only amounts to $\frac{1}{11}$ part of the heat carried away by the condensing process, and $\frac{10}{11}$ *of the heat used is constantly wasted*. On this ground I contend that the principle of the steam engine involves a misapplication of heat in producing mechanical power. In the caloric engine only a small portion of heat is wasted, or carried away by the cooler, and on that ground I contend that it will produce more power than the steam engine by a given quantity of fuel.

3d. The reviewer states, that "the volume of air cannot be readily lessened when once expanded." This is utterly fallacious, for the actual operation of the regenerator of the trial engine proves just the contrary, and I have it in my power to name a great number of the most eminent scientific men in the kingdom in support of my statement, they having witnessed the actual operation.

4th. The reviewer "suspects" that atmospheric air contained in a close vessel will remain equally *dense* in every part, although of unequal temperature. *I* suspect, that if at one end of that vessel the air be kept at about 480° higher temperature than at the other, it will *there* be at only half *density*, or *specific gravity*, compared to the other end. As to the pressure exerted against the sides of the vessel, no one is so ignorant as not to know that it is equal at every point.

5th. The reviewer is laboring under a strange delusion as to the respective pressures in the *body* of the regenerator, and in its *pipes*. These pressures I have most distinctly stated to be equal to 56 inches column of mercury in the former, and 18 inches in the latter. There being no vacuum about the engine, these columns must, of course, be both subjected to atmospheric pressure, consequently the pressure indicated by them are pressures above the atmospheric pressure. Moreover, to prevent misconception on that part, it has been particularly pointed out, in a note, where *particular pressure on a vacuum* was meant.

6th. The reviewer has been anticipated in his advice to have mercurial gauges communicating with the body of the regenerator, as well as with its pipes, for the pressures stated in the pamphlet are those indicated by gauges now actually attached to the engine.

7th. The reviewer's confused statements with regard to effective pressure and back pressure, and his equally confused conclusions as to the power of the trial engine, need no refutation, since he has proceeded on false data, being ignorant of the rapidity of the transfer of the heat, and of the actual pressures in the various parts of the machine. But I must inform the reviewer that, without "magical effect," the mean resistance against the piston of the cold cylinder is only 14 lbs. to the square inch. If the reviewer ever noticed that when the piston of a blowing cylinder first is moved, it meets with hardly any resistance, but that resistance increases as the piston is pushed farther into the barrel of the pump, he will readily see why the piston of the cold cylinder cannot be opposed by a pressure equal to 19 lbs. to the square inch, until it has performed nearly the half stroke; and he will also, by a short calculation, find that the *mean resistance* throughout the stroke will be very nearly 14 lbs.

8th. With regard to the mean pressure against the working piston, I will only ask the reviewer to consider what would be that resistance, supposing air of 19 lbs. to the square inch was admitted into the working cylinder and the *admission valve closed*, when the piston had performed $\frac{3}{4}$ of the length of the stroke; he will, I am sure, find 17 lbs. will be very near the mark.

9th. The reviewer, instead of allowing himself to be "struck with surprise at the idea of there being a power of 13 horses communicated to the main shaft," should have undertaken to multiply 154, (the square, in inches, of the working piston,) by 17, (mean pressure in pounds,) by 165, (speed per minute in feet.)

10th. The reviewer thinks that the air is "wire-drawn" in the slide passages. This I beg most decidedly to contradict; for all the apertures about the slides are $7\frac{1}{2}$ inches square, which is considerably more, in proportion, than in low pressure steam engines.

I am, sir, yours obediently,

JOHN ERICSSON.

Edward street, Regent's Park.

Farther Illustration of the Principle of Mr. Ericsson's Caloric Engine. [From the London Mechanics' Magazine.]

SIR,—The following remarks, in elucidation of the principle of my Caloric Engine, will, I feel confident, not be unacceptable to your many scientific readers.

To arrive at a clear understanding of the advantage gained by the new mode of employing heat adopted in this engine, it may not be amiss to pause for a moment to consider how heat is at present made use of when employed to actuate that universal instrument of mechanical power, the steam engine. Is it necessary *to the effect produced*, that the heat should be absorbed or destroyed, or in any way diminished in energy?

If this question can be answered in the negative, then it will be quite logical to assume that the power of the steam engine forms but a fraction of that which the combustion of a given quantity of fuel is capable of producing.

Well, then, let us suppose a quantity of steam, of known volume and pressure, to be admitted into a vessel containing cold water of a given weight and temperature; the elevation of temperature which will be produced will, of course, afford an accurate measure of the quantity of heat contained in the steam previous to its condensation. Suppose, now, that an equal volume of steam, of equal pressure, as in the first instance, is admitted under a piston, working in a cylinder, and subjected to a proportionate load; that piston will, of course, move until all the steam has been admitted, and by its motion exert a force proportionate to the pressure of the steam and the volume displaced. Let, then, the steam be discharged from under the piston into the vessel of cold water, under similar circumstances as in the first supposition, and it will be found that the *same* elevation of temperature will take place as when the steam was not previously employed to raise the piston. We thus find that *the production of mechanical force by heat is unaccompanied by any loss of heat.**

But, in the steam engine, this remarkable circumstance is not productive of any advantage, for although nearly all the heat generated in the boiler is unquestionably conducted to the condenser, that heat cannot from thence be brought back to the boiler again for the purpose of raising steam, having in the condensing process been diffused amongst a large quantity of matter, and brought to a much lower temperature than the steam.†

On these grounds the inference seems incontestible, that the steam engine is not constructed on a correct physical principle, inasmuch as it consumes a greater quantity of that precious commodity, fuel, than is necessary for the production of the mechanical force obtained.

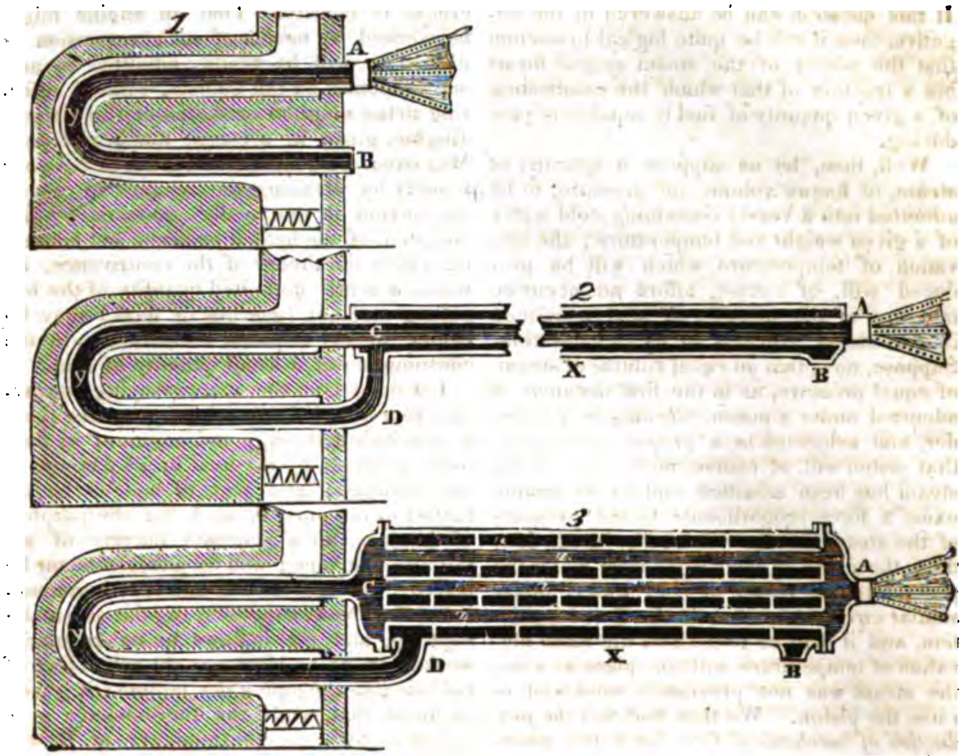
It is well known that all fluid substances, the gases particularly, expand very considerably by being exposed to the action of heat, and that, if kept in a state of compression previous to being heated, their expansive force will, at a given temperature, be greater, and that in the same proportion as the increase of density. That an engine might be worked by means of such expansion or dilatation, will be readily admitted by any one reflecting on the subject, without referring to the diagram or sketch of the Caloric Engine, given in a recent number of your Magazine. I will, therefore, not detain your readers by detailing the manner in which the motion is practically produced by the dilatation of the heated medium, but confine myself to the theory of the contrivance, by which a nearly unlimited quantity of the impelling medium, (gaseous or fluid,) may be heated to any required temperature, by the consumption of a small quantity of fuel.*

Let fig. 1 (see the accompanying engraving) represent a furnace having a metal tube, *y*, conducted through the centre of its flue, to be acted on by the heat in its passage to the chimney; let a pair of bellows be attached to the pipe, *y*, at A, for the purpose of keeping up a constant current of air through that pipe; and let a thermometer be inserted into it at A, and another thermometer at B. Now, suppose a regular fire to be kept up, and the bellows to be regularly worked so as to blow, say 20 cubic feet of cold air into the pipe *y* per minute: if it then be found that, whilst the thermometer at A indicates 60°, the thermometer at B will continue to indicate 100°, it follows, as a matter of course, that the heat transmitted by the furnace per minute will be accurately ascertained by calculating what quantity of heat is required to raise 20 cubic feet of air from 60 up to 100°. Now suppose the same furnace, with its metal tube *y*, to be represented by fig. 2, but instead of having the bellows attached to the metal tube, suppose them to be attached to a pipe, A C, of infinite length, and let this pipe be inclosed in a casing, X; suppose, further, this casing to be surrounded by a perfect non-conductor of heat, and instead of allowing the hot air to pass off directly, as at B in fig. 1, let it be conducted from the metal tube *y*, through the pipe D, into the casing X, and pass off at B. Then let thermometers be inserted in the pipes at A, C, D, and B, the bellows being worked at the same speed as before, and an equal fire kept up. At the commencement, the thermometer at A and at C will, of course, both indicate 60°, but the thermome-

* Losses by radiation need not here be taken into account, for they do not affect the theory.

† Of course, every boiler is fed from the condenser, but this produces a saving of fuel of only one-thirteenth part of the whole quantity consumed: hence thirteen-fourteenths of the heat generated is constantly wasted.

* The journal cited in my last communication having, by some strange oversight, mistaken the Caloric Engine for an "Air Engine," it will be well to direct the attention of your readers to the fact, that various gaseous and even fluid substances, capable of considerable dilatation by heat, are equally applicable for using the heat over and over again, and for the reason that the *impelling agent may be varied*, while, in every case, *caloric is indispensable*, has the term *Caloric Engine* been chosen.



r at C will very soon begin to rise, on account of the heat conveyed into the casing X; but any increase of temperature at C will, of course, cause an increase of temperature at D. This again will still further increase the temperature at C, and so on in continued succession, until the thermometer at D indicates a temperature nearly equal to that of the hot air in the beginning of the flue leading from the furnace: any further increase of temperature, of course, cannot take place. Now, since the quantity, or rather weight, of air forced through the metal tube *y* is the same as in the first proposition, and the power of the fire likewise, this latter proposition, illustrated by fig. 2, incontrovertibly proves that the *temperature* to which the air may be brought is made perfectly independent of the *quantity* of heat generated in the furnace.

But the *quantity* of air to be heated will also be equally independent of the *quantity* of heat generated: for suppose that, in the first proposition, the draught be checked so as to diminish the consumption of fuel ¾, then the 20 cubic feet of air constantly circulated per minute will be raised about 10°, instead of 40°; but apply the contrivance for bringing the heat back, as illustrated in fig. 2, and the thermometers at C and D will be affected just as above described, except that more time will be required before the temperature at D is brought to the full height, and that less heat will ultimately escape at B. Thus it may be proved *theoretically*, that any quantity of fluid air or gaseous matter can be heated up to a high temperature, independently of the quantity of heat actually generated for that purpose. Although this is apparently a paradox, it is not so; for by referring to the illustration in figs. 2 and 3, it will at once be seen that the circulating fluid is of a *high temperature only when passing the point* D, and that it gradually diminishes in temperature as it recedes, and gradually increases as it advances towards that point. However, for the purpose of obtaining mechanical force this is quite as advantageous as if the fluid retained its high temperature when it escapes; for at the point D is the heated fluid admitted into the working cylinder, and from thence passed off into the casing X. The manner in which this is done, your diagram of the Caloric Engine, in a former number, fully explains.

Fig. 3 represents the form of an apparatus used in practice; its operation is precisely the same as in fig. 2, and thermometers placed at A, C, D, and B, will indicate temperatures proving the increase of temperature and transfer of heat in a similar manner.

The cold fluid is forced into the furnace through a number of small tubes, Z, and the hot air is passed off through the vessel X, called the regenerator. The currents, both in this vessel and in the tubes, are broken in a peculiar manner, so as to produce a constant intermixture of particles, which is absolutely necessary for effecting a rapid transfer of heat. But to such an extent has this object been attained by the contrivances instituted, that hot air, constantly passed at the rate of 6 feet per second, through a pipe 1¼ inch bore, fourteen feet long, and entering at a temperature of 300°, has, by a counter-current of *equal magnitude*, been brought down to 85°, the counter-current at the same time entering at 72°.

I remain, sir, yours, &c.

J. Ericsson.

Edward st., Regent's Park, Jan. 7, 1834.

Meteoric Phenomenon. By S. Boyden. To the Editor of the Mechanics' Magazine.

Sir,—I read with pleasure the remarks of Mr. Strong, in your Magazine, on the phenomenon of the 13th of November. If accurate observations have been taken from places at any considerable distance apart, the distance of the meteors from the earth may be computed. I saw them from four o'clock, as long as they were visible. I agree with you, that the point from which they appeared to diverge advanced to the west, but remained the same with regard to the stars; this point was near the 20th degree of Leo, 5 degrees north of the Ecliptic, which was 20 degrees south of the zenith, at 30 minutes past 6 o'clock, being near the point in the heavens towards which the earth was going in its orbit. If the shoal of meteors through which the earth has passed were nearly at rest, the motion of the earth would give to the meteors the appearance they presented of diverging from the point the earth was advancing to; and if they were not equally electrified with the earth's atmosphere, they must become luminous on entering it, and remain so until the equilibrium was restored, leaving the excited electricity in the atmosphere through which they had passed, to return to rest and cease to be luminous. I am not informed that any of them touched the earth, or to what extent they have been seen, though probably they were visible in the parallel of west longitude, between 30 and 160 degrees, or to more than one third of the earth.

Hoping to receive further information, I remain yours respectfully,

Seth Boyden, Engineer.

Newark, N. J., Feb. 15, 1834.

On the Location of Railroad Curvatures, being an investigation of the principal formulas required for field operations in laying curves to pass through given points. By J. S. Van De Graaff. To the Editor of the American Railroad Journal.

Sir,—Having been personally engaged in tracing the various curves for railroad lines, and being frequently under the necessity of making calculations relative to divergent curves and tangents, under a variety of existing circumstances, I was induced to enter into an investigation of certain formulas, embracing the principal cases which usually occur in practice. These formulas, the chief of which I believe to be new, are now offered to you for insertion in your Journal. This is done only with a view to the possibility of adding a small mite to the general stock of information upon that subject; for nothing can be better calculated to produce such an effect than a comparison of the different methods of computation which have been resorted to by different individuals engaged in the solution of such problems. A full investigation of this subject, embracing all the variety of cases which occur in the field, would require too much room in your columns, and I have therefore consulted brevity as much as perspicuity would allow. Very respectfully,

J. S. Van De Graaff.

Art. 1. Any two points being fixed in the general direction of a route, through which it is proposed to lay a line of railroad composed of several curves and tangent lines, the cost of construction is in most cases not the only requisite datum to fix the definite location of the intermediate points,—for there are very few varieties of ground, except in a very broken country, which will not admit of several different lines connecting the same points, all at nearly an equal expense of construction, and all within the same *limits* of curvature. It then becomes an object to make such a selection of right lines and curves, and such a distribution thereof, as will produce, *at a given expense*, the most efficient road.

But no particular rule can be given as a guide for the judicious arrangement of a line; and the general object here proposed is an investigation of such formulas as are required in the field. Let any two rectangular co-ordinate axes be assumed, and take any number of *equal* straight lines, originating at the origin of the co-ordinate axes, and connected together at their extremities in such a manner as that, when each point of connection is joined by a straight line to the origin, these latter lines will form, with one of the co-ordinate axes, a series of angles in *arithmetical progression*. It then follows, agreeably to the principles of elementary geometry, that each point of connection of these equal straight lines, will be situated in the cir-

cumference of a circle, passing through the origin, and touching that co-ordinate axis from which the arithmetical series of angles is counted. And this obviously suggests the common method of tracing a circular arc in the field by means of a chain whose length is each of those *equal* straight lines, and an instrument for measuring the arithmetical series of angles from the tangent line.

In all the formulas which will be deduced in the course of the present inquiry, it must be remembered that all measurements of distance are supposed to be made in chains, or decimal parts of a chain. The chain will therefore be the *unity* of length, and may have any value whatever; but as this will be a constant quantity in the field, it follows that the *curvature* of a line, traced in the manner just described, can only be made variable by different arithmetical series of angles. The *common difference* of these series of angles will therefore be called the *moduli* of curvatures, and will always be denoted by a letter T. That co-ordinate axis which coincides with the tangent line will be designated as the axis of x; the other being that of the ordinate y; and any curve will be considered given, or found, when the modulus of curvature is given, or found.

2. *Let a given curve be traced from the origin of a system of rectangular co-ordinate axes, agreeably to the preceding article; it is proposed to investigate formulas which will express the values of the co-ordinates of the station at the extremity of the* n*th chain.*

The inclinations of the different chains to the axis of x, in succession from the origin, are respectively T, 3T, 5T, &c.; and consequently their projections upon the co-ordinate axes are obviously cos. T, cos. 3T, cos. 5T, &c., and sin. T, sin. 3T, sin. 5T, &c. respectively. Hence, by taking the sums of those projections, the following equations will result:

$$x = \cos. T + \cos. 3T + \cos. 5T + \text{\&c.} \ldots \cos. \{T\cdot\overline{2n-1}\}$$

$$y = \sin. T + \sin. 3T + \sin. 5T + \text{\&c.} \ldots \sin. \{T\cdot\overline{2n-1}\}$$

The last term in each of these two series will obviously be the nth term; and the sum of n terms of each series being taken, agreeably to the known principles of analytical trigonometry, the following formulas will be the result:

$$x = \frac{\sin. 2nT}{2 \sin. T}$$

$$y = \frac{1-\cos. 2nT}{2 \sin. T}.$$

These are the expressions required; and they have that form which is most convenient for computation from a table of natural sines and cosines.

3. *To find the radius of curvature.*

It is sufficiently evident, that when n is made *variable*, the maximum value of x will be the radius of the described circle; but when x is a maximum, it follows that sin. $2n$T will also be a maximum when T remains constant, as will readily appear from the expressions obtained in the last article. Now, the maximum value of sin. $2n$T is unity, and consequently denoting the radius of the described circle by R, the result is,

$$R = \frac{1}{2 \sin. T}.$$

4. *Take two rectangular co-ordinate axes, having their origin at a given station in a tangent line, from which a certain required curve is to be laid, passing through a point designated by the co-ordinates* x, y; *the given tangent line coinciding with the axis of* x. *Parallel respectively to each of the co-ordinate axes, let any number of rectangular lines be traced from the origin, and terminating in the point designated for the required curve to meet; these rectangular lines being selected in any convenient manner to pass any obstacle which may happen to occur. Let the algebraic sums of each of these rectangular lines be taken, agreeably to the axis to which they are respectively parallel. These sums will obviously give the values of the co-ordinates* x, y; *and from thence it is proposed to determine a formula expressing the value of the modulus of curvature of the required curve.*

Let each of the two formulas obtained in art. 2 be squared; and let the second of the two formulas be then divided by the sum of the squares. The following expression will be the immediate result:

$$\text{Sin. } T = \frac{y}{x^2 + y^2}.$$

And thus the modulus of curvature of the required curve becomes known. This is one of the most important formulas used in the field; for it can be applied under any circumstances, when the designated point is not visible from the origin. If that point can be seen from the origin, the curve sought is usually obtained in a more simple manner.

5. *Suppose two curves to be laid upon the same tangent line, and take* b *to denote the distance between their origins. Let one of those curves have a given modulus of curvature denoted by* T, *and let it pass through a given point at the extremity of the* n*th chain. It is then proposed to find the modulus of curvature of the other curve such that it may also pass through the same given point.*

The co-ordinates of the given point, taken with reference to the origin of the required curve, will obviously be $x \mp b$, and y. Hence taking T′ to denote the required modulus, it follows from the last article that, sin. T′ $= \dfrac{y}{\overline{x \pm b}|^2 + y^2}$. Now, substituting in this expression, for x, y, their values obtained in art. 2, and the necessary reductions being made, the following formula will be the result:

$$\text{Sin } T' = \frac{1-\cos. 2nT}{\dfrac{1-\cos. 2nT}{\sin. T} \mp 2b \sin. 2nT + 2b^2. \sin. T}$$

This theorem will be found to be quite convenient in the field to answer several different purposes, when the curves are too long to be within the limits of the more simple approximative methods. With regard to the double sign, it must be observed that the *negative* value obtains, when the origin of the curve sought is in *advance* of the origin of the given curve; and the positive value must be taken in the contrary case.

6. If the point designated for the required curve to meet does not coincide with the extremity of the *n*th chain of the given curve, as in art. 5 it is supposed, but varies a small distance to the right or left; yet, *if the curves are long*, the best method will always be to compute the value of T', as though the required curve were intended to pass through the point considered in that article; and then the requisite *small variation* in the computed value of T', to meet the case proposed, may be subsequently calculated by very simple approximative methods.

7. *Suppose two given curves to be laid upon the same tangent line, and let* b *denote the distance between their origins. Take* T *and* T' *to represent the given moduli of curvatures; and* n *and* m *the number of chains contained in each curve respectively. It is proposed to determine the distance between the extreme stations of those two curves, and the inclination of the two tangents at those two extremities.*

I will here take T to denote the modulus of curvature of that curve which is most in advance upon the tangent line, with respect to the directions in which the curves are laid from their origins. Let x, y, and x', y', be the respective co-ordinates of the two extreme stations, each originating at the origin of its respective curve. The difference of co-ordinates, when referred to any common origin on the tangent line, will then be $x + b - x'$, and $y - y'$. Hence, taking w to denote the distance sought, the common principle of analytical geometry gives the following expression:

$$w = \{\overline{x+b-x'}|^2 + \overline{y-y'}|^2\}^{\frac{1}{2}}$$

And from this equation the required distance becomes known; for, by art. 2,

$$\left.\begin{array}{l} x = \dfrac{\sin. 2nT}{2 \sin. T} \\[2ex] y = \dfrac{1 - \cos. 2nT}{2 \sin. T} \end{array}\right\} \quad \left.\begin{array}{l} x' = \dfrac{\sin. 2mT'}{2 \sin. T'} \\[2ex] y' = \dfrac{1 - \cos. 2mT'}{2 \sin. T'} \end{array}\right\}$$

The inclination of each tangent to the common tangent at the origins is $2n$T and $2m$T' respectively, and $2n$T—$2m$T' will consequently express the required inclination of the two tangents to each other. These two tangents will converge when $2m$T' is less than $2n$T, and the determination of their point of intersection will be easily effected by the preceding principles.

8. When the two moduli of curvatures T and T' are equal, the problem considered in the last article becomes much more simple. For the value of w being developed, and the values of x, y, and x', y', substituted for them, and the necessary reductions being made agreeably to the known principles of analytical trigonometry, the following formula is the result:

$$w = \left\{ \frac{1 - \cos. \{2nT - 2mT\}}{1 - \cos. 2T} + b \times \frac{\sin. 2nT - \sin. 2mT}{\sin. T} + b^2 \right\}^{\frac{1}{2}}$$

This expression will be useful for a variety of purposes in the field.

9. The formulas which have been investigated in the 8 preceding articles are all *rigorously accurate*; and when long curves are under consideration, which embrace portions of circumferences containing more than 20° or 30°, these formulas will find their application; for, in such cases, none of the *usual methods* of approximation are applicable.

The above very brief view of this subject will be only sufficient to illustrate the general fact, that all the necessary formulas are easily made to flow from the two principal formulas given in art. 2. Very useful approximative rules may also be easily derived from those already given; but I cannot continue this inquiry. The subject may perhaps be resumed in some future number of this Journal.

Van De Graaff.

Lexington, Ky., February, 1834.

Engineer's Manual.—We publish the following extract from the preface of a forthcoming work, believing that in so doing we shall confer a favor on many of our readers. The author of the work is a practical engineer, engaged upon one of our western railroads, and has often furnished us with valuable communications for the Magazine, signed "V. D. G." We hope to be able to make further extracts from the work itself, by which those most interested in it may be able to judge of its utility to the profession.

In presenting the present little work to the notice of the public, the author is actuated with the hope of contributing in a small degree to the collection of such principles as are daily required in locating railroad curvatures with ease, accuracy, and despatch. The author has not possessed an opportunity of ascertaining extensively what may be the various methods of calculation at present resorted to by scientific and skillful engineers generally, in determining the relative positions of given points in the different curves and tangent lines which frequently come under consideration in the field; and the principal formulas which are here offered to the public, embracing these cases, are therefore *such only* as have been used with advantage by himself. The only methods of calculation which he knows to be *now in use by others*, and which are sufficiently commodious for purposes in the field, are of an approximative kind; and under circumstances which often occur, the use of those approxi-

mative results is attended with inconvenience and delay. It is therefore hoped that the different formulæ which will be here found investigated and arranged for use will be acceptable to those who may not be in possession of more convenient methods of computation, which are sufficiently rigorous to pass a *long curve* through a given point at the first attempt.

The second part of this Manual is devoted to the methods of constructing the elliptical curve. It is well known that the true curve of an ellipsis is produced by an oblique section of a cylindrical surface, whether that surface be circular or elliptical; and hence it is that the true figure of an ellipsis should be traced with precision in the construction of skew bridges, having either circular or elliptical arches. Other cases in the department of a civil engineer might be mentioned, in which a perfect ellipsis is required; and there is no method available in practice hitherto published, which is known to the author, for constructing an oval, consisting of given circular arcs, and approaching with sufficient precision to the curve of an ellipsis.

A table of natural sines and cosines is to the engineer almost of daily use. Such a table is therefore subjoined to this work. It is also thought desirable to add a table of the square and square roots of numbers; which not only very frequently saves labor, but will also be the means of diminishing the liability to err in numerical calculations. Indeed, those two tables, or others of a similar kind, will be considered indispensable to the skillful prosecution of all field operations, by those who know the facilities which may be derived from them.

Estimated Expense of Construction of the Wood Work of Railroads. By E. Johnson. To the Editor, &c.

Sir,—Agreeably to your request, I forward the estimated expense of construction of the wood work on the plan suggested in my communication. (See page 121.)

Reported expense to the directors of the Buffalo and Black Rock Railroad Company:

10560 feet, lineal measure, of round timber hewed on one side, at 2½ cts.	$264 00
36960 feet of plank, $12 per M.	443 52
7040 feet oak scantling, 2 by 4 inch, $7,	49 28
2640 lbs. spike, 8 in. (4 to the lb.) 8½ cts.	224 40
16 tons iron, 2 in. by ½ in., $55,	880 00
Additional security at the end by sills and iron, distribution of materials, incidentals, &c.	100 00
Labor in putting down road, (sills placed in the grade by the contractor for grading,)	84 00
Expense per mile,	$2045 20

The estimated cost of the construction of the Tonewanda railroad from Rochester to Attica, 43 miles, on this plan, with sills 12 inches in diameter, plank 2½ inches thick, 20 tons of iron per mile, spike 3 to the pound, as reported to the directors, is, per mile, $2544 63.

The principal saving in the expense is in the grading. Where the surface conforms nearly to the level of the road, the line is cleared, the sills placed in their proper position, and ample ditches cut to form the grade. More than half of the distance of the Tonewanda railroad line is of this description, and can be prepared at a small expense per mile, in consequence of the change in the form of the wood work.

I have made arrangements for putting down with lime, in April, one mile on the Buffalo road, to be done in the following form, viz: using 2½ bushels of stone lime per rod, 1½ bushels slacked and placed on the sills and over the surface of the grade before putting down the plank; one bushel made into grout and applied to the surface of the planking when the road is completed, covering the surface and filling the joints of the timber, and then covered with sand:

Requiring 800 bush. per mile, at 10 cts,	$80 00
Labor, - - - - - -	20 00
Expense per mile,	$100 00

You have anticipated on this form of road the use of common carriages. This manner of using the road was submitted to the commissioners of the Tonewanda railroad in November last, with a view principally of using the first twenty miles from Rochester for market teams, allowing them to enter the road at certain hours in the forenoon, and afternoon to return, and so arranged as to not interfere with trains of cars; which would require the track to be five feet wide, in place of four feet nine inches, the usual width, which would not be materially objectionable. This question must be decided by experiment and circumstances.

I am, respectfully, yours,

Elisha Johnson, Civil Engineer.

Rochester, Feb. 28, 1834.

Mr. Nutt's System of Bee Management. [From a Friend of this distinguished Apiarian.]

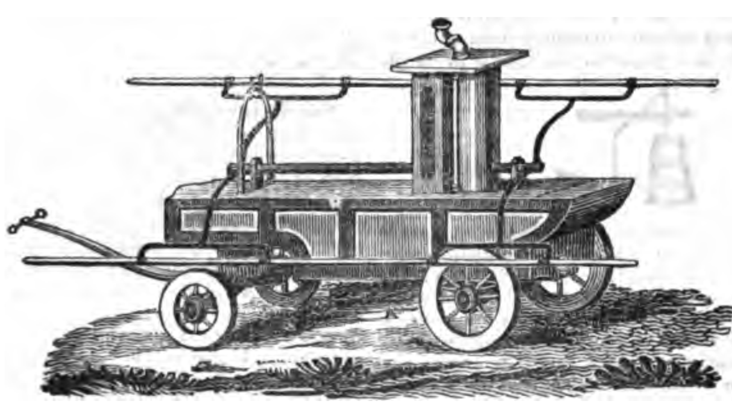
It is one of the least interesting pleasures of an editor's duty to record the successful achievement of designs to which he has devoted his helping hand, to place in successful practice and deserved estimation the efforts of inventive genius, to whatever part of the wide fields of research its attention may have been devoted; and multifarious as are the objects which address themselves to his attention, in his varied capacity, as treasurer of scientific improvement and discovery, or dispenser of their benefits, it is ever a source of gratification that those exertions have been requited with merited success.

Since the first promulgation of Mr. Nutt's views, the Mechanics' Magazine has been the vehicle for the publication of his plans, and the furtherance of his designs. That they were possessed of originality and merit was evident, by their requiring neither sophistry

nor mystery to impress them on public attention, for they claimed regard more from their simplicity than the extension at which they aimed. The pages of this Journal were alike open to the results of his patient investigation and research, as well as the queries of his opponents, and we are confident that, even to those proficient in ordinary modes of Bee Management, or who adhered with pertinacity to their usual modes, much good was elicited.

To the Mechanics' Magazine Mr. Nutt returns his obligations for the impetus which, through its medium, has been given to his system, the remuneration which he has received for his labors, and the great and extended success which has in every instance attended its introduction.

The system has now become one of facts, which are now sufficiently numerous, not to prove its superiority over all others which have preceded it, but to render its introduction a matter of important, national, economical consideration. To recapitulate individual instances of its success were only to refer to what has been extensively published in this journal. The superiority of the honey and its chemical characters are based upon the same foundation; and we therefore feel that in taking leave of the subject as a theory, or its success as merely problematical, by placing it upon permanent record, it will only be necessary to give such instances of its established success, as will at once silence the objections of rivalry. An inspection of the exhibition of the varied collections this season, at the National Gallery of Practical Science, in Adelaide street, where it has stood the test of the strictest examination, and has been the subject of much attention and inquiry, will sufficiently prove the correctness of this observation. The results of Mr. Nutt's takings, during the present year, from six colonies, has been seven hundred pounds of honey, averaging from one hundred to one hundred and twenty pounds from each hive; nor has he been alone in these marked proofs of success, as a reference may be made to the Apiaries of the Marquis of Blandford, Delabere House, near Reading; Rev. Thomas Clark, Gedney Hill; John Burman, Esq., Wisbech; and J. D. Salmon, Esq., Stoke Ferry, Norfolk, where the average products have been the same.



Rogers' Patent Balance Fire Engine.—Engines of this description are manufactured at Waterford, Saratoga county, New-York, on an extensive scale, and the company do not hesitate to recommend it to the public as decidedly superior to any fire engine now known. It has been tested by skilful engineers at the United States Arsenals at Gibbonsville and Washington, and by them pronounced to be superior to any other. The Government Arsenal at Washington is now supplied with one of said engines, and the proprietors have on hand a contract with the government for the supply of all their principal arsenals.

This engine combines the advantage of more power at less cost than any other in use, and needs only to be examined and tried to insure it a preference to all others.

We have much pleasure in inserting the following certificate:

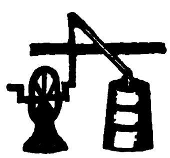
"I have this day superintended a trial of a fire engine of Rogers' patent, made by William Platt & Co. at Waterford, Saratoga county, New-York, with one of the best Engines belonging to the Corporation of the city of New-York. The trial was made in the Corporation Yard, and from the experiment, I am fully persuaded that the engine of Rogers' patent will throw more water, and at a greater distance, with the application of less power than our Corporation en-

gines. No fire engine has ever been exhibited in this city which could compete with the New-York engines, or which would answer our purpose, except Rogers' patent above mentioned. The construction of Rogers' patent is exceedingly simple, and I see no reason why it should not go into general use. Besides, it has another advantage—it can be furnished at much less cost.

"James Gulick,
"Chief Engineer N. Y. Fire Dep."

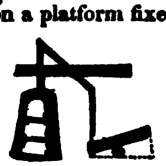
Dutch Churns.—When the churning process was going on, I have observed the outside of the churn wrapped over with cloth, which I was told was for the purpose of keeping the outside clean. The Dutch have various ways of working the churn. At the large dairies it is generally with a horse; this I observed near Delft, at Ter Leide, near Leyden, and near Leuwarden, in Vriesland; at others they are churned by the hand, by turning a large fly-wheel,

1



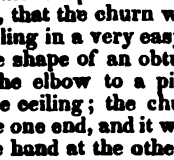
(figure 1.) At Almenaar, near Harlingen, I saw a churn made to go by the feet, the weight of the body being moved alternately from one side to the other, on a platform fixed on a pivot (fi-

2



gure 2); to the one end of the platform a stalk being attached, which moved the churn-handle attached to another pivot. I observed at a farm near Gouda, that the churn was made to work from the ceiling in a very easy way; a piece of wood, in the shape of an obtuse angle, was attached at the elbow to a pivot in one of the beams of the ceiling; the churn-stick was attached to the one end, and it was worked up and down by the hand at the other end, (figure 3.)

3



And in North Holland they churn by means of dogs in wheels, in a similar way to the turnspits.—[Quarterly Journal of Agriculture.]

Luminous Plants.—In the case of the rhizomorphæ there can be no mistake. These curious plants are found in subterranean cellars and mines, and illumine the darkness which surrounds them with their magic light. In some of the coal mines of Dresden they are singularly beautiful and brilliant. Mr. James Ryan once informed me that he was accidentally shut up in a mine, and the light of one of the rhizomorphæ was so brilliant that he could see distinctly to read a letter by it. As the rhizomorphæ prey on dead wood, they impart to it a phosphorescent light. The rhizomorphæ phosphorentia is found in the mines of Hesse, and yields light in the dark, but ceases to be phosphorescent in hydrogen and some other gases: the rhizomorphæ subterranea and acidula have also been found to illumine the mine with their fairy light. Mr. Erdmann thus describes the luminous appearance of the rhizomorphæ in one of the mines of Dresden: "I saw luminous plants here in wonderful beauty; the impression produced by the spectacle I shall never forget. It appeared, on descending into the mine, as if we were entering an enchanted castle. The abundance of these plants was so great, that the roof, the walls, and the pillars, were entirely covered with them, and the beautiful light they cast about almost dazzled the eye. The light they give out is like a faint moonshine, so that two persons, near to each other, could readily distinguish one another. The light appears to be most considerable when the temperature of the mines is comparatively high." That the light is electric seems most probable, when we consider that an electric discharge imparts phosphorescence to Canton's phosphorus, (calcined shells,) and that heat enhances the light.—[Murray's Physiology of Plants.]

Air Plants.—These attach themselves to the driest and most sapless surface, and flower as if issuing from the richest soils. "A specimen of one of these, which I thought curious," says Dr. Walsh, "I threw into my portmanteau, where it was forgotten; and some months after, in unfolding some linen, I was astonished to find a rich scarlet flower in full blow; it had not only lived, but vegetated and blossomed, though so long excluded from light, air and humidity. The barren pine is not less extraordinary. It also grows on sapless trees, and never on the ground. Its seeds are furnished, on the crown, with a long, filmy fibre, like the thread of a gossamer. As they ripen they are detached, and driven with the wind, having the long thread streaming behind them. When they meet with the obstruction of a withered branch, the thread is caught, and, revolving round the seed, at length comes into fixed contact with the surface, where it soon vegetates, and supplies the naked arm with a new foliage. In Brazil it grows like the common plant of a pine apple, and shoots from its centre a long spike of bright scarlet blossoms. In some species, the leaves are protuberant below, and form vessels like pitchers, which catch and retain the rain water, furnishing cool and refreshing draughts to the heated traveller, in heights where no water is to be found. The quantity of this fluid is sometimes very considerable, and those who have attempted to reach the

flower-stem have been often drenched by upsetting the plant.

CAPACITY OF BODIES FOR WATER.—As it may be interesting to many to know the comparative as well as the positive absorption of water by various bodies, we subjoin the following table, the details of which were made with care. The weight of each substance was ascertained before immersion; next, when the water ceased running and began to drop; and, lastly, when all dropping had ceased, and the bodies were in that state in which they may be supposed to be full of moisture.

	Dry.	*Dripping.*	*Done dripping.*
Flannel........	144 grs.	1553 grs.	700 grs.
Woollen Cloth..	56 "	370 "	191 "
Linen	375 "	2110 "	1050 "
Calico.........	115 "	1150 "	450 "
Cambric Muslin.	95 "	883 "	307 "
Very fine do.	54 "	715 "	297 "
Glove Leather..	106 "	1170 "	677 "
Kid do. ..	172 "	770 "	421 "
Shoe do. ..	95 "	194 "	177 "
Sponge........	185 "	2440 "	2070 "

From these data the following table may be constructed, to show in the first instance the absorbing powers, and, in the second place, the retaining powers, for moisture, of the various bodies thus experimented upon:

Flannel absorbed	11	and retained	5	times its weight of water
Woollen Cloth	6½	"	3½	"
Linen Cloth	5½	"	3	"
Calico	10	"	4	"
Cambric Muslin	9	"	3½	"
Fine Muslin	13	"	5	"
Glove Leather	11	"	6½	"
Kid do.	4½	"	2½	"
Shoe do.	2	"	2	less a fraction
Sponge	13	"	11	"

From these results, it may be seen that, although some substances, in the first instance, take up an equal or nearly an equal quantity of water with the sponge, such as the flannel, fine muslin, and glove leather, yet their powers of retaining the same are very far inferior.

DIP AND DECLINATION OF THE NEEDLE IN AMERICA.—A manufacturer of compasses at Birmingham would feel much obliged to any of our American or other correspondehts, who would supply answers to the following queries: What is the dip and declination of the needle in New-York? and the extent of the variation throughout that and the other states of the North American Union?—[Mec. Mag.]

MAGNETIC POLE.—We understand that the position of the Magnetic Pole is now finally ascertained by our adventurous countryman, Captain Ross. He has actually been on the spot where the dipping needle becomes vertical, or points straight downwards; while the horizontal needle, having, as it were, no longer any thing to point towards, remains indifferently in any direction given it.—[Athenæum.]

Captain Ross has ascertained beyond question that the Magnetic Pole is nearly in 70° N. lat., and 97° W. long., being 2° of lat., and 3° of long. different from what it was said to be by Captain Parry's observations.—[Naval and Military Gazette.]

PERCUSSION LOCKS FOR THE ARMY.—A committee, consisting of three officers of artillery, is now actively engaged at Woolwich in a course of practical experiments, of which the object is to ascertain the propriety, or otherwise, of introducing percussion locks for the army, in lieu of the present flint and steel. No report is, we hear, to be made to government till the firing of 24,000 rounds of cartridges shall have afforded grounds for a decided opinion.

PRESERVATION OF SUBSTANCES BY MEANS OF ALKALIS.—M. Payen has preserved, during many months, polished instruments of iron and steel, by keeping them in solutions of potash and soda,—saturated solutions diluted with one, two, or three times their weight of water. He at first thought that the preserving power depended upon the disappearance of the air, and the carbonic acid in the alkaline mixture, but he afterwards concluded that alkalinity acted an essential part in the phenomenon. In fact, a very small quantity of alkali is sufficient; thus, $\frac{1}{1000}$ and even $\frac{1}{2000}$ of caustic potash in water will preserve from oxidation bars of iron, &c. immersed in it. Lime water, diluted with its own weight of water, or of course without dilution, answers the same purpose. Alkaline carbonates and borax have the same effect, but they must necessarily be stronger.—[Revue Encyclopedique.]

DOMESTIC SILK HANDKERCHIEFS, the product of the native mulberry, have been manufactured in Dayton, Ohio, which are said to exceed the imported ones in durability.

METHOD OF DRESSING SKINS PRACTISED IN MAROCCO.—The following account of the method practised in dressing skins in Marocco was transmitted to the Zoological Society by W. Willshire, Esq., a Corresponding Member of that Society, in a letter dated Mogadore, May 5, 1833. Its results are stated to be excellent, as regards the preservation and color of the fur, and the flexibility of the pelt.

Wash the skin in fresh water to deprive it of the salt; as soon as this is done, scrape the flesh off, when take two pounds of alum, one quart of buttermilk, and two or three handfuls of barley-meal, which mix well together, and lay on the fleshy side of the skin equally; fold up and press it together carefully, and let it lie two days. On the third day take it to the seaside, wash the skin well, and when clean and free from mixture, hang it up to let the water run from it: then take two pounds of alum finely powdered, and throw or spread it equally on all parts of the skin; again fold up as before, and allow it to lie three days, when it will be in a proper state to dry in the sun, laid flat, without taking away the powder. When it is dry, take a pint or two of fresh water, and sprinkle it upon the skin, and again fold it up carefully for about two hours, to imbibe the water; then lay it on a table, and, after scraping it free from the mixture and flesh, take a sand-stone (rather rough) and rub the skin well until it becomes

soft and pliable, then hang it in the shade to dry. The process is then complete.

When the skin is perfect, having the head, horns, &c. take off the horns, and fill their cavity with a mixture of equal parts of powdered alum and ashes of charcoal dissolved in water, and expose them two days to the sun. Saturate the trunks of the horns with eight ounces of alum dissolved in water, and fold up with the skin, and apply the same on each occasion when employed in curing the skin. The flesh on the head and jaws to be carefully taken off, filling the same with powdered alum. It should remain in the sun until perfectly dry.

In addition to the foregoing description of the mode used in Marocco, in dressing skins, as related by the persons employed by Mr. Willshire, it may be well to observe that the process does not take so long at Mogadore, as Mr. W. has often received back skins of the Aoudad and Leopard from the dresser, on the third or fourth, and never exceeding the fifth day, perfectly cured. Allowance has been made by the dresser, in the foregoing description, for the difference in the climate of London.

The skins of smaller animals must not be subjected to so lengthened a process, or they will become harsh, and the pelt impoverished. —[Proceedings Zoolog. Soc.]

Apparatus for obtaining Fire.—A very ingenious apparatus is now exhibiting at the store of Mr. John Bailey, in Union street, for obtaining fire. It consists of two glass cylinders, the outer one of which contains a compound of sulphuric acid and water, and in the inner one, which is without a bottom, is suspended a piece of zinc. The action of the acid upon the zinc creates a gas, which is let out by means of a valve, and, in coming in contact with atmospheric air, immediately ignites a piece of platina exposed to it. The apparatus is very neat, and was constructed by a young man in Mr. Bailey's employ, from a description of a similar work in Europe.—[New-Bedford Gazette.]

Receipes.—*For an Olive Green.* Let the article be first washed in soap and water, then wetted out in warm water; then boil two ounces of chipped logwood and three ounces of chipped fustic together for half an hour; dip out your dye liquor, and put it into a pan with hot water; put in your goods; dissolve two drachms of verdigris in a teacup full of warm water, which put into a pan of cold water; take your gown from the dye, and run it through the verdigris water, well handling it for ten minutes; take it out and wash it in clean water, and through the dye liquor, and again in the verdigris water, and so continue this process till you obtain the color required, only taking care to wash it out of the verdigris water before you put it in the dye liquor: dry it in the shade.

For Yellow Cotton.—To make a lemon yellow, first wash your article well in soap and water, then rinse it in warm water. For every yard of stout cotton, dissolve a piece of blue vitriol as large as a horse bean, in boiling water; and when the water is at a hand-heat, put the cotton in, and handle it for half an hour. In the interim take a quarter of a pound of weld for every yard of cotton, and boil it well for half an hour; dip the liquor out in a pan, and handle your cotton through this till it comes to the fullness required; take it out to cool, and when cold, wash it out, and dry it in the air.

To preserve Books.—A few drops of any perfumed oil will secure libraries from the consuming effects of mould and damp. Russian leather, which is perfumed with the tar of the birch tree, never moulders; and merchants suffer large bales of this leather to remain in the London docks, knowing that it cannot sustain any injury from damp. This manner of preserving books with perfumed oil was known to the ancients. The Romans used oil of cedar to preserve valuable MSS. Hence the expression used by Horace, "*Digna cedro,*" meaning any work worthy of being anointed with cedar oil, or, in other words, worthy of being preserved and remembered.—[Greenf. Gaz.]

To preserve Eggs.—Apply with a brush a solution of gum-arabic to the shells, or immerse the eggs therein; let them dry, and afterwards pack them in dry charcoal dust. This prevents their being affected by any alterations of temperature.

To make Maple Sugar.—It has been customary to cut a gash in the tree, from which saccharine liquor flows, or to bore a hole, and put in a reed, and, when the liquor ceases to flow, plugging up the hole. Both these methods are injurious, and tend to destroy the tree. In the latter case, the tree roots round the plug to some distance within. The following method is proposed in lieu of these, and has been successfully practised in Kentucky. At the proper season for running of the liquor, open the ground and select a tender root, about the size of one or two fingers; cut off the end, and raise the root sufficiently out of the ground to turn the cut end into the receiver. It will emit the liquor from the wound as freely as by either of the other methods. When it ceases to flow bury the roots again, and the tree will not be hurt.

To restore Tainted Beef.—In the last fall I procured an acquaintance of mine in the country to put up a barrel of fat beef for my family's use during the winter. The barrel of beef was sent to me agreeably to contract; but before I had used one quarter part of it I observed it tainted, and so much so as to smell quite offensive. The beef being very fat and fine I was loth to throw it away. I made the following experiment: I procured a half bushel of charcoal, and after taking out the beef and throwing away the offensive pickle, I re-packed it in the barrel, laying the pieces of charcoal between the pieces; and making a new pickle, and adding a little saltpetre, I covered the beef, and in about six days found it as sweet and good as it was when first put up.

MECHANICS' MAGAZINE,

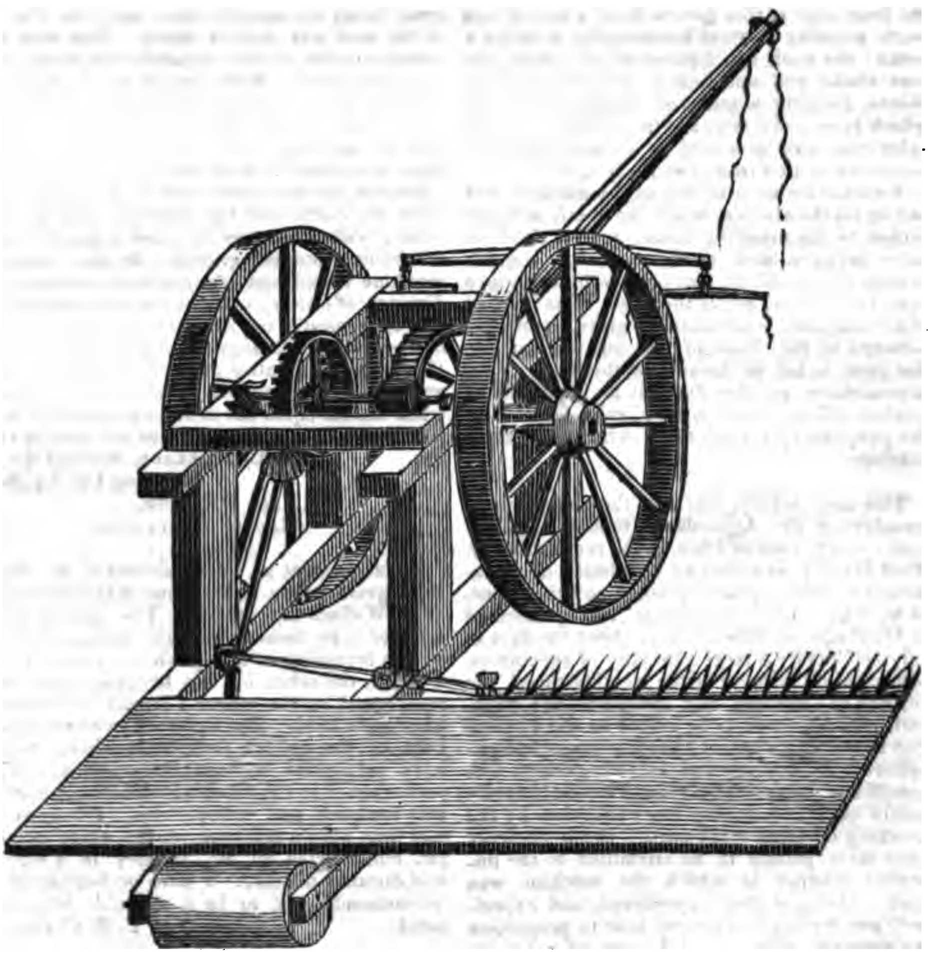
AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] APRIL, 1834. [NUMBER 4.

"How unhappy would man be without an interchange of thought! The mind would be as riches coffered; their shining beauties eternally buried and prevented from beneficially circulating among society."—SPECTATOR.

HUSSEY'S GRAIN CUTTER.



Description and Drawing of Hussey's Grain Cutter. Communicated by the INVENTOR.

[We have seen one of Mr. Hussey's grain cutters, manufactured in this city by Messrs. R. Hoe & Co. It is a simple, substantial machine, and from its construction and the perfect manner of cutting a little artificial field of grain, we would add our own recommendation to that of the respectable names in the certificate. The inventor is about taking it into the grain regions of the western part of the state, to exhibit its operation at the next harvest.]

This machine consists of a frame of good oak or ash, sustained by two wheels forward, and one wheel or roller in the rear, and is constructed in the following manner: Two sills are connected by several cross rails; on these sills are fixed four posts; two top rails are framed to the tops of the posts, parallel with the sills, and connected also with cross rails, as seen in the plate. To the forward posts is hung the main axle, with journals running in metal boxes: on this axle the wheels are fixed with square boxes: these wheels sustain the forward part of the machine, and furnish the cutting power. Across the rear ends of the sills is fixed a plank floor of good pine, extending several feet beyond the right wheel. This floor is horizontal, and its distance from the ground will be the length of the stubble. On the front edge of this floor is fixed a row of iron teeth, pointing forward horizontally, forming a comb: the teeth are formed of two parts, one part above and one below, and joined at the points, forming a range of mortices, through which runs a saw with the teeth sharp on both sides: this saw is moved by a crank which receives its motion from the main axle.

Two horses are attached to the machine and driven on the stubble, when the teeth are presented to the standing grain, which they receive between them, as the saw with a quick motion cuts it off, the morticed teeth forming a bearer above and below the saw. The velocity of the machine, while cutting, gives an impulse forward to the butts of the straws, causing the grain to fall backwards on the floor. As it accumulates on the floor, it is deposited or pushed off in heaps with a rake formed for the purpose, by the operator, who rides on the machine.

This may certify, that we, the undersigned, members of the Agricultural Society of Hamilton county, state of Ohio, at the request of Mr. Obed Hussey, attended an exhibition of a machine for cutting grain by horse power, invented by him. The experiment was performed at Carthage, in this county, about the first of July last, before a large company of spectators, composed of farmers of the neighborhood, the citizens of Carthage, and several from Cincinnati, who appeared to be united in the expression that it was a valuable improvement in agriculture. In our opinion the experiment was completely successful, although several impediments occurred during the exhibition by the breaking of some weak parts; these obstructions were plainly to be attributed to the imperfect manner in which the machine was made, it being a first experiment, and experience not having yet taught how to proportion the strength of the several parts to meet the stress which each part might be subject to, on its trial, some pieces being of wood, which should have been of iron; but we have no doubt but all these imperfections can be remedied in a second machine. We were satisfied that the impediments referred to were not to be ascribed to any defect in the principle, for, while the machine was in operation, the performance was complete, until some part broke by the violence to which it was subjected, it having two horses attached to it, and they several times driven on a brisk trot; at this speed the grain was cut as well, or better, than when the horses were driven slow. The machine performed well, both at the rate of two and a half and five miles per hour; and although the horses were several times urged, they were not driven so fast at any time as to determine at what speed the machine might be moved, and do good work. The wheat was found to be cut much cleaner, and to be left in better order for binding, than when cut by the cradle. The saw which cuts the grain was made without a temper for cutting, consequently would not continue sharp long at a time; but no difference was perceived in the execution, the grain being cut equally clean, and fast, whether the saw was dull or sharp. This was attributed to the peculiar construction of the cutting apparatus. With regard to the quantity of grain which the machine is capable of cutting in a given time, we can only say, that we saw the machine move at the medium rate of three and a half or four miles per hour, cutting a swarth five feet three inches wide; and we have no doubt but the machine may be extended with advantage to a half a rod in width on ordinary smooth ground. In this case the machine would pass over one acre in going the distance of one mile. From the general satisfaction expressed at the exhibition alluded to, and our own impressions, we would recommend Mr. Hussey's grain cutter to the notice of all grain growers, being satisfied ourselves, that if future trials should equal the first experiment, it will be a valuable improvement to all large farmers.

D. C. Wallace, Sec'y of the Hamilton Co. Ag. So'y
J. D. Garrand,
Calvin Carpenter.

I was present at the exhibition of Mr. Hussey's grain cutter, and concur in the statement of D. Wallace and others. The impediments referred to by them were in one instance caused by the loosening of a cog wheel by loss of the wedges, the other by the breaking of a two-inch wood screw, where a strong bolt should have been used. But for these two casualties, I am of the opinion that the machine would have performed without interruption. The performance of the machine while in operation was complete and satisfactory. I have since that time seen a machine on the same principle, constructed by Mr. Hussey, in a strong and durable manner. I have no hesitation in recommending it to be a valuable improvement.

T. B. Coffin.

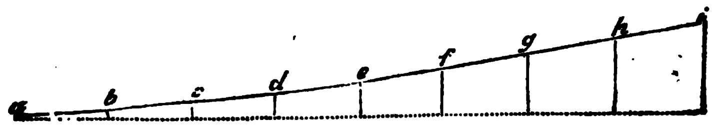
H. Huxley & Co., 81 Barclay st. New-York, are agents for selling the above machine.

The Undulating Railway. [From the London Mechanics' Magazine.]

Sir,—To prevent the possibility of any further misunderstanding in reference to the experiments recently made on the Liverpool and

Manchester railway, I have this morning called upon Mr. Booth, and have compared with his statement thereof the following particulars of the rise of the Sutton inclined plane, from its base to a higher point of elevation than any which was attained in our experiments. To render this explanation more clear, on which reliance may be placed, I have accompanied it by a diagram, wherein is denoted the points from which the ascents and descents, during the experiments, were measured.

I am extremely sorry that these particulars have not before been published, as the want of them has evidently produced inconvenience to some of your correspondents, which, had it occurred to me, I ought not to have permitted.



From *a* to *b*	the distance is	88 yards	—rise 1 in 754—	total elevation	.116 yards
b to *c*	"	88 "	—rise 1 in 122—	"	.721 "
c to *d*	"	88 "	—rise 1 in 105—	"	.838 "
d to *e*	"	88 "	—rise 1 in 97—	"	.907 "
e to *f*	"	88 "	—rise 1 in 94—	"	.936 "
f to *g*	"	88 "	—rise 1 in 92—	"	.956 "
g to *h*	"	88 "	—rise 1 in 89—	"	.988 "
h to *i*	"	88 "	—rise 1 in 89—	"	.988 "
		704 yards		Total rise,	6.450 yards.

The ascent of the Sutton inclined plane may be said (see diagram) to commence at the point *a*; although for a distance of 2¼ miles before arriving at that point there is a trifling ascent of about 1 in 2,640—viz. from the Sankey viaduct to the foot of the plane.

Now, the series of experiments first published (see No. 531), and which were tried with the Rocket engine, were made from what was considered the foot of the plane, and which in the diagram is marked letter *b*.

The results of those experiments evidently proved to me that the inclination of that part of *the plane* on which they were tried was not, as generally supposed, 1 in 96. I perfectly recollect Mr. Sanderson alluding to some supposed error, though why the allusion was "*not palatable to me*" is a perfect mystery. It was not, however, until after I sent you the particulars of the experiments, and my return to Douglas, that I had an opportunity of making such calculations as led me to call a second time on Mr. Booth, viz. *before* the trial of the second series of experiments, and explain to him the discrepancy which appeared. For instance, see page 21, experiment 6:—The Rocket engine and a load of 35 tons ascended by *momentum* 134 yards, the velocity at the foot of the plane being 10 miles per hour, which ascent was equal to 4.1875 feet perpendicular elevation. Now, 10 miles per hour is 14.672 feet per second, and supposing friction out of the question, a body having gained a momentum of 14.672 feet per second, by gravity, would only ascend 3.36855 feet. Thus it was evident to me that 1 in 96 was not the proper inclination of that part of the plane. Previously, however, to the experiments afterwards detailed, the levels were taken afresh by the Messrs. Dixon,* and in the experiments tried with the Liver and load on the 16th (see No. 534,) the ascents were measured from that part of the plane marked × in the diagram, at which point there is a cottage on the railway. On the Sunday following it was agreed by the engineers present that the place of starting should be again changed, and the experiments with the double load were all made from that part of the plane from which the Rocket had ascended, viz. from *b*. It will naturally occur to your readers—if Mr. Badnall were acquainted with all these particulars, why did he not lay them before the public? The fact is, that I considered the result of the experiments made with the Pluto and Firefly, with the *double* load, such as to render all explanation unnecessary with regard to the previous trials, and especially *as I stated at page* 71, that the inclination upon which those latter experiments were tried was about 1 in 99, which will be found to be the average. Moreover, I did not at the time consider a knowledge of the exact inclination of the plane at all necessary to a clear comprehension of the nature and results of the experiments, inasmuch as *all I wished to prove was*, that *whether velocity* was generated by one or more engines at the foot of ascent, by which velocity (either with or without the continued assistance of one engine) a given elevation was surmounted, *a greater velocity could be generated by descending the same distance*, evidently proving, beyond all rational doubt, the correctness and value of the principle.

The discrepancy alluded to by "Kinclaven" will be explained, I trust, satisfactorily to him, by referring to the statement of the experiment to which he alludes. In that instance the word *momentum* is not introduced; on the contrary, the whole power of the Liver engine was employed throughout the *whole ascent*. Had this not been the case, there evidently must have been some great error. I need not say that I shall be most happy, not only to give

* I had also an opportunity of comparing, this morning, my notes on the rise of the inclined plane with Mr. Dixon's, sen., from whom I had originally been favored with them.

every further information in my power, but if any of my opponents will propose any further practical test, upon the result of which they will cast the merits of the question, it shall be, if possible, immediately and most impartially tried.

As a proof of the impartiality with which I have recorded the experiments already tried, I refer to all the engineers present, whether the *steam* of the Pluto (see last experiment) was not shut off 155 yards before she arrived at the starting post, which made a very considerable difference in the rise by momentum. Seeing, however, that I had *proved* enough, I neither complained at the time, nor have I hitherto published my complaint. The error arose from the two conductors of the engines shutting off the steam of both engines when the flag dropped for the first engine to shut off on passing the mark, letter *b*.

May I again ask if Mr. Cheverton and "S. Y." will be satisfied that there is an advantage if a given locomotive engine will move, at a given velocity, *double* the load from summit to summit which she is capable of moving on the level at the same velocity? If so, will they, if not satisfied with the impartial judgment of our northern engineers, attend on an appointed day, of which they shall have due notice, and witness the experiments themselves? If they refuse to attend, and if they disbelieve the results of the experiments already tried, it is needless to make a single further comment on their opposition. On the other hand, if they do attend, and if they do witness a decided proof that a load, which *will not move on a level*, will move from summit to summit of an undulation at a *great velocity*, what becomes of the "ASSUREDLY NOT" of the *Champion*—and why is it necessary that "S. Y." should give such friendly advice to Mr. Ham, and to the subscribers of the *great western railway?* I am, however, happy in believing, that a full and impartial trial of the undulating principle will *soon* be made on rather an extensive scale; and I hope "S.Y." will state his *practical objections*, and that the *Champion's rod* may be most freely *exercised* before such *trial takes place*. As to the sickness which these gentlemen complain of, I am sorry I can administer no better restorative than my regret.

I am, sir, with great respect,

RICHARD BADNALL.

Manchester, November 28, 1833.

P. S.—I observe that "S. Y." makes some allusion to "*The Editor of the Manchester Guardian.*" Probably he is not aware that Mr. Garnett, the editor, is an opponent of mine, and *one* for whose mechanical attainments I have a very high opinion.

The Undulating Railway—Resistance from Friction—Resistance of the Atmosphere—Mr. Badnall in reply to S. Y., Junius Redivivus, and Mr. Cheverton. [From the London Mechanics' Magazine.]

SIR,—Seven months have now elapsed since the undulating railway was first introduced, as a subject of discussion, in your Magazine. During that period I have done my utmost, by fair and conscientious argument, to support the cause which I undertook to defend; and the gratification which I now feel in having witnessed your honorable and candid confession of a changed opinion, and in finding myself supported by several of your most able correspondents, far more than compensates for the disappointment which the opposition of "S. Y." would naturally excite, even should it be continued after the publication of this letter, and after the important facts determined by the experiments. I say *disappointment*, because, if still unconvinced, he will, I fear, ever remain inconvincible; and, judging from the occasional piquancy and asperity of his remarks, he is not likely to be more fairly defeated, without losing, in some measure, that evenness of temper which I should be sorry to disturb. If I do him injustice, I apologise for it; but I feel that the time is now arrived when (practical experiments having decided the merits of the question) I have no longer occasion to defend myself by parrying the verbal attacks of my opponents. On the contrary, I waive all further hypothetical discussion on this subject, unless such discussion refer to the result of my late or future experiments. In coming to this conclusion I am not considering my own convenience, but I think your readers in general will agree with me, and with your friend, *Professor Crackwell*, that unless we draw in our horns, the undulating controversy will not only become sickening, but, judging from Mr. Cheverton's last letter, somewhat disgusting. "*Nec lusisse pudet, sed non incidere ludum,*" said Horace, and I quite agree with him.

You, Mr. Editor, or an impartial jury of your readers, must judge whether I am led to this train of thinking through *fear* of my opponents, or whether I am not justified in claiming the victory I have contended for. Those gentlemen who have advocated my side of the question—*Sæcula, Mr. Ham, Mr. Sanderson, Kinclaven, Mentor*, and *Mr. Trebor Valentine*,—have each and all supported my position by convincing diagrams, appropriate comparisons, or disproved experiments; whereas neither "S. Y." nor Mr. Cheverton have thought proper to substantiate their reasoning by a single particle of corroborative evidence. That both are clever men, I do not for one moment question; but a clever man occasionally errs; and never is he more likely to do so than when inflated with that unhappy quantity of combustible matter,—vulgar abuse, self-sufficiency, and extreme vanity,—which have been so conspicuously displayed in the disjointed lectures which Mr. Cheverton has directed to me on this subject. For those lectures I am indebted to him, especially for the last, which I shall presently take into consideration, and which, I trust, will be headed in your title-page, "THE PROFOUND IGNORANCE OF MR. BADNALL DEMONSTRATED BY THE SUPREME SENSE OF MR. CHEVERTON"!!

My present object is to reply to all unan-

swered objections which have been raised by my opponents up to this time. In doing this, I may probably introduce some opinions which may appear open to further discussion; but as I fully concur in the sentiments expressed by φ. μ. (No. 582), as to the frequently injurious effects of a too protracted controversy, I shall feel it an act of duty to your readers to be a silent observer of any attacks upon them. I place them on record as my deliberate and conclusive opinions; and having done so, I turn from *theory* to *practice*, and now present myself to your readers as the defender of the undulating principle in a far more important point of view—I mean in defence of its *complete practicability*.

In thus a second time throwing the glove, allow me to prognosticate what will be the result of another year's experience. Within that period, engineers and mathematicians will have an opportunity of making up their minds upon the subject, and from the expiration of that time *we shall never have another level railway* (whereon locomotive steam force is intended to be employed) *laid down in Great Britain*. The Liverpool and Manchester railway, though it will ever maintain the character of being one of the most important examples of British spirit, British perseverance, and British ingenuity, will, in the eye of posterity, have one dark spot upon its fame—it will be compared to the massive and expensive aqueducts of the ancients. Our forefathers knew not that water would find its own level —and, while we praise their structures, we cannot help wondering and smiling at their ignorance. Thus, however, will posterity smile at us, exclaiming, "*Could you have believed it! They expended, in about thirty-one miles, hundreds of thousands of pounds to make a railroad level*, through their disbelief *that all bodies descending on a curvilineal arc will rise again to their own level, minus friction!*"

I now turn to "S. Y."—a few words afterwards to Junius Redivivus; and then, in perfect good humor, to Mr. Champion Cheverton.

A desire to remove, if possible, every opposition founded on mathematical reasoning, which has been urged against the undulating theory, induces me to return to "S. Y.'s" first communication. Before doing so, however, I must at once contend against the liberty which he takes in stating that I have betrayed ungentlemanlike conduct by my observation, "that I should have felt hurt that any other correspondent than himself had doubted my proficiency in common arithmetic." The "indignation" of "S. Y." cannot possibly justify such an observation.

In "S. Y.'s" letter, page 181, there is an error in print, afterwards corrected, which rendered his first formula "incomprehensible." I allude to the omission of the decimal dot before the figure 8. In the succeeding column, however, I find this misprint did not occur; I therefore ought to have understood his object better than I did. But allowing that I had fully comprehended it, and that such misprint had not occurred, I observed that the whole formula was founded on false data, and that the position which he took was altogether untenable. I refer now to the saving of friction "*abstractedly*," without allusion to the difference in velocity occasioned by the action of gravity, to which latter point he also frequently alluded, when he denied that the speed could be greater on a curve than on a level line. With regard, then, to the real difference of friction on the two roads, he gives the following proposition, which I have thought it better to describe by diagram:

Fig. 1.

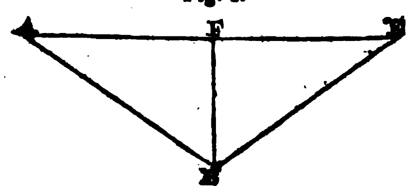
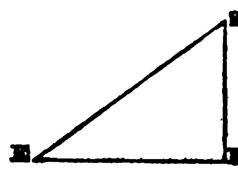


Fig. 2.



"If A E (fig. 1) be equal to 16, and the depth F B equal to 6, the length of each inclined plane will be equal to 10, and the pressure against the plane; and therefore the friction, according to Mr. Badnall, will be equal to ·8 of the friction on the level."

Now "S. Y." must have misunderstood my diagram, *p. 93, to which he refers, and which was, I think, clearly elucidated. If he *did understand it*, from whom did he draw his conclusion, that I imagined the friction or pressure on the inclined plane E B, whose perpendicular elevation is equal to F B, equal to ·8 of the friction on the level?

Let him suppose, then, (reversing the above diagram, as fig. 2,) the plane E B raised upon the base E F, at an elevation of F B. It cannot be doubted (as proved by the parallelograms described in my diagram, page 93,) that if the base line E F represent the pressure (or friction) of the whole weight resting on the plane E B, F B will represent the force of gravity down the plane; or, in other words, as the length of the line F B is to the length of the line E F, so is the pressure or friction taken *off* the inclined plane E B to the pressure or friction *left on the inclined plane*; or, to be more explicit, if a body be supposed to weigh 10 tons, and to be placed on the hori-

* On referring to this diagram I find the length of the level line E A=22, the length of each inclined plane=[illegible] and the elevation=2·5; if, therefore, we deduct 2·5 from the length of F A, we shall find the reduction of friction of pressure nearly one-fifth.

zontal line E F, no one can dispute that, the line of pressure being vertical, the *whole weight of the mass* must necessarily press upon the rail. If, then, E F were exactly equal to F B, and the weight were removed to the inclined plane E B, the pressure would be reduced *one half;* and thus, in the above diagram, E F being equal to 8, and F B equal to 6, and supposing any weight resting on E B to be divided into 14 parts, $\frac{8}{14}$ths of the whole weight would be resting on the rail, and $\frac{6}{14}$ would be taken *off* the rail.

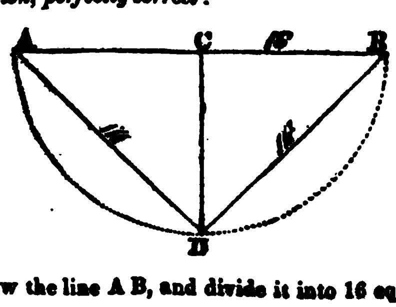
By this explanation it will be evident that "S. Y.'s" second formula, page 242, is, like to his first, established on wrong data, *for he never takes into consideration the perpendicular elevation of the plane;* and it is this which has evidently misled him, or otherwise he would not consider his argument to hold good for "all lengths and *elevations* of inclined planes."

"S. Y." considers in both formulæ the pressure to be determined by the *base*, divided by the *length of the inclined plane:* he consequently draws in each case an erroneous conclusion, for there can be no doubt whatever that, *as the perpendicular height of the inclined plane is increased, the pressure or friction of any carriage moving on that plane is reduced.*

Referring to the preceding diagrams, nothing can be so easy as to determine the *exact* proportion which subsists between the pressure or friction on an inclined plane, and the pressure or friction on a horizontal plane, provided the angle of elevation be given. In the case before us we have the angle F E B. Now, let P be the pressure on the base, or horizontal line F E, and let p be the quantity taken off that pressure, owing to the inclination of the plane, and let a be the angle of inclination: we then have *in all cases*—

$$p : P :: F B : F E$$
$$\text{but } F B : F E :: \text{tangent } a : 1$$
$$\text{therefore } p : P :: \text{tangent } a : 1$$
$$\text{and, consequently, } p : P \text{ tangent } a.$$

If, then, the amount of friction or pressure on an inclined plane (speaking abstractedly of friction or pressure) be reduced in proportion to the angle of inclination, it must, I should hope, be evident to "S. Y." that his position is wrong. He, no doubt, will allow that the pressure at an angle of 45° is reduced *one half.* To make myself, therefore, perfectly clear, I will take this angle to prove his formulæ *incorrect*, and the undulating theory, *in regard to friction, perfectly correct:*



Draw the line A B, and divide it into 16 equal parts. From the centre C describe the semicircle A D B. Draw the line C D perpendicular to A B, and from the points A and B draw the straight lines A D, B D.

Now, as before observed, because the perpendicular line C D is equal to the line B C, any weight descending on the line B D will press with exactly half the force with which it would have pressed on the level line A B, the angle C B D being an angle of 45°. Divide, then, the lines B D, A D, into an equal number of parts, each part being equal to $\frac{1}{16}$th of the horizontal line A B$=22\frac{2}{5}$. Next suppose a body, weighing 10 tons, to press upon every described part of the line A B, in passing from A to B: we then have $16\times10=160$; but if 10 tons press upon each part of the horizontal line, *half that weight*, according to the proposition, will only press upon each part of the lines B D, A D.

We have, therefore,

$$22\tfrac{2}{5}\times5=112$$

and, consequently, $160-112=48$ difference in total pressure.

But it may be argued, that if the semicircle A D B were divided into an equal number of like parts, the total number to be passed over on the curve would be 25·142; but this argument will not obtain, it being mathematically true (see Sir Isaac Newton, Parkinson, Hutton, and others,) that the velocities which bodies acquire in falling either down inclined planes, or curvilineal arcs, are precisely alike, viz. as the square roots of their perpendicular heights; and if the acquired velocities are equal, it is self-evident that the resistance opposed to motion down each line is also equal.

Let us now examine to what result "S. Y.'s" formulæ would bring us.

Let B represent B C
L " B D
n pounds equal to the force of traction on a level at any given velocity.

Then the pressure on the line B D (according to "S. Y.") will be to the pressure on the level as $\frac{B}{L}$ is to 1; and therefore the force of traction required in consequence of friction on the inclined plane, will be to the force of traction on the level as $\frac{B}{L}n$ is to n. According, then, to "S. Y.," the entire expenditure of power to move the wheel the horizontal distance on the level will be Bn, and on the inclined plane it will be $\frac{B}{L}n\times L=$ Bn as before. Thus he makes, at an angle of 45°, the pressure or friction on the lines A D and B D equal to the pressure or friction on the horizontal line A B; whereas I make the difference in friction as 7 to 10, or $\frac{3}{10}$ths in favor of the semicircle A D B.

Again, referring to "S. Y.'s" letter (No. 531), wherein he fully explains the bearing of his formulæ, the erroneous view which he has taken of the question is again evident. For, taking 5 ounces (as he suggests) to represent

the force of traction on the level, and applying his observations to the angle of 45°, we shall find that the calculation will not be, as it would arise if his formulæ were correct, viz. $16\times5=80$ on the level, and $22{\cdot}40\times{\cdot}71428571=15{\cdot}999$, or very nearly 16; consequently, $16\times5=80$ on the inclined plane, as before.

But, instead of the force of traction on the semicircle being equal to the force of traction on the horizontal line, we should have it as follows:

$16\times5=80$ on the level,

$22{\cdot}40\times2{\cdot}50=56$ on the curve,

precisely agreeing with the reduction of friction before mentioned, viz. $\frac{3}{10}$ths in favor of the semicircle.

So much for the question of friction, considered abstractedly, and as *commonly* understood; but it must be evident to every man who has perused the particulars of the experiments, that the amount of reduced friction, as in this instance considered, according to the angle of the inclination of the plane, cannot be taken as the precise measurement of power saved, by the adoption of the undulations. On these interesting points I trust that some valuable information may shortly be laid before the public in a treatise on railways,* locomotive engines, &c., which Mr. Robert Stephenson, sen., and myself, are preparing for the press. Previously to that time we shall try various experiments, and I have no doubt, from the plans which we intend adopting, and the precision with which the experiments will be made, that the laws of motion and resistance, under various circumstances and velocities, will be more clearly developed than they have hitherto been. The results which I anticipate lead me to quote a remark of Hooke's in the year 1666: "Gravity, though it seems to be one of the most universal, active principles in the world, and consequently ought to be the most considerable, yet has it had the ill fate to have been always, till of late, esteemed otherwise, even to slighting and neglect."

I have no apology to make to "S. Y." for considering L as a proper symbol for the *length* of the plane, which was ascended with a given velocity, especially as the spaces in most of the experiments varied on every trial. For an error in the last equation, I, however, have to apologise, and I must beg "S. Y." to read L+D for L D—. The word "INVERSE," which he alludes to in his letter (No. 531, p. 23,) was an unintentional omission of mine (see page 222), where, for "*is in proportion*," I evidently intended to say, "*is in inverse proportion*." Any person who reads the sentence will, I hope, give me credit for this.

In reply to the observation of Junius Redivivus, (No. 532, page 38,) let me beg him to place a heavy ball upon a plank, then raise the plank to a vertical position—he will allow that, because the weight falls perpendicularly, there is *no pressure* on the plank. Let him, then, raise the plank on which the same weight rests to an angle of 45°. He will, no doubt, admit that the weight will descend, and that the velocity of descent on the effect of the force of gravity will be in proportion to the diminution of pressure or friction on the plank. Let him next support the weight on the plank (the latter still being inclined at an angle of 45°), by placing his hand under it, or some machine by which he can accurately measure the pressure: he would, I have no doubt, find that precisely *half* the weight was resting *on the plank*, and *half* the weight *upon his hand*, or upon the instrument by which he was measuring the pressure. Let him, then, withdraw his hand, and what becomes of the weight? Half is still remaining on the plank, and the other half is suspended in the atmosphere until it reach the earth which attracts it. Surely, on consideration, Junius Redivivus will acknowledge the truth of this reasoning, and if so, he cannot dispute that the greater the angle of the inclination of the plane the less will be the pressure or friction of any body, either ascending or descending, on such plane.

And now for Mr. *Champion Cheverton!*

The first explanation which I think due from me to your readers, and to which "*The Champion*" principally alludes, is in reference to *the resistance of the air*. I stated, in a former letter, that I thought that *the resistance of the atmosphere* did not (a constant power being employed to urge the body forwards, or, like gravity, downwards,) increase as the squares of the velocity—that the resistance of the air does not act as a greater opposing force (alluding, particularly, to the flight of birds, and to the motion of railway carriages,) at high velocities than at low velocities—that, consequently, the velocity of a train of carriages, supposed to be descending an inclined plane of interminable length, *never could in practice become uniform*; but, on the contrary, that in *theory* the uniform acceleration would not begin to cease until the resistance of the air was equal to the force of descent, which it could not be until the body had attained a velocity equal to that at which air would rush into empty space. I further stated, that it was my opinion "that the resistance of the air, when first overcome by any locomotive force which is constantly and equally continued, does not, throughout EQUAL SPACES or DISTANCES, act as an opposing force with greater intensity at high velocities than at low velocities"; but that, on the contrary, it was my opinion that the *total resistance* of atmosphere, throughout a *given distance*, is *less* at high velocities than at *low velocities*, *from the inclination* which all bodies have to rise from the surface of the earth *when in rapid motion*, and, consequently, from a denser to a lighter atmosphere.

Now, sir, I should have felt not only that an explanation, but that a public apology was due from me, had I published these opinions, without having *very strong reasons* for believing

* The resistance of the atmosphere, and the *cause* of that resistance not increasing as the squares of the velocity, will be particularly elucidated in this treatise by careful experiment.

them to be true. I know they are diametrically opposite to received opinions: *so was the undulating railway;* but time, and careful experiments, will prove whether I am right or wrong. I will now explain my reasons for believing that *I am right.*

In the first place, that there are many doubts existing as to the *true* theory of atmospheric resistance is evident, by the following remark by Hutton: "We conclude (he says) that all the theories of the resistance of the air hitherto given are very erroneous, and the preceding one (alluding to the generally entertained opinion) is only laid down till further experiments on this important subject shall enable us to deduce from them *another* that shall be more consonant to the true phenomena of nature." Surely this admission is a sufficient apology for the humble attempt which I have made, and for the attempt which Mr. R. Stephenson and myself are now making, to investigate this subject.

I must now request the attention of your readers to the following experiments, tried down inclined planes, by Mr. Nicholas Wood, with a view of measuring the friction of railway carriages. (See his work on Railways, 2d edition, pp. 211–213, &c. &c.)

Mr. Wood, in reference to these experiments, thus writes: "Standing on the end of a carriage, and aided by an assistant, at the end of every ten seconds I made a mark upon the plane where the carriage happened to be, and afterwards measured the distance between those marks, which gave the space passed over in each successive period."

Carriage weighing 9,100 lbs.; wheels, 34 inches; axle, 2¼; friction, 44·62 lbs.

Seconds.	Feet.	Real space, the descent not being uniform.	
In 10 the body fell	6·6	6·	feet.
20	26·4	26·4	"
30	59·4	59·8	"
40	105·6	106·2	"
50	165	165	"
60	237·6	242·8	"
70	321·4	326·7	"
80	422·4	424·3	"
90	534·6	525·3	"
100	660	625·5	"

The above experiment was tried at the Kenilworth colliery.

Now, in examining the result of this experiment, if Mr. Wood were correct in his measurement, and upon his correctness I have placed dependence, it is evident that the resistance of the atmosphere did not increase as the squares of the velocity of the moving body, but that, *for some reason or other*, with which reason the public will soon, if I mistake not, be acquainted, it was equable in effect through equal spaces throughout the entire distance of descent.

We know that if a body fall, in vacuo, a given space in the first second of time, it will have fallen four times the space in the two first seconds; that if it fall 16·1 in one second, it will have fallen 64·4 in two seconds; because 16·1 ×4 (4 being the square of the times)=64·4.

Again, if it fall 1608 feet in 10 seconds, it will fall 6432 feet in 20 seconds, or twice the time; because (omitting fractions) 1608×4=6432.

Now it appears, according to Mr. Wood's *measured* experiments, that in 10 seconds the carriage fell 6·6 feet, and in 20 seconds 26·4.

Now 6·6×4=26·4, which is in exact accordance with the laws of falling bodies.

Again, in 40 seconds, the carriage fell 105·6, and in 80 seconds 422·4.

Now 26·4×4=105·6
and 105·6×4=422·4.

Again, in 30 seconds it fell 59·4, and in 60 seconds 237·6.

Now, 59·4×4=237·6.

Lastly, in 50 seconds it fell 165, and in 100 seconds 660;

and 165×4=660.

Now, had the resistance against the rolling carriage increased as the squares of velocity, the descent *could not have been in accordance with the laws of bodies falling in vacuo.*

I will, however, refer to other experiments, and try the question by another test:

Descent of loaded carriages weighing 9,408 lbs.; wheels, 35 inches diameter; axles, 3 inches.

In 18 seconds the carriage fell	25	feet
28	71·9	"
38	124·6	"
48	205·2	"
58	276·5	"
68	384·7	"
78	506·1	"
88	645·5	"
98	785·3	"
108	939·6	"
118	1081·6	"
128	1266·5	"

Fall, 1 in 104—friction, 41·45 lbs.

Now, in vacuo (taking 16 ft. as the correct measurement in the first second of time), a body in 18 seconds would fall 5210·892 feet, and in 28 seconds 12608·072 feet, and in 38 seconds 23223·852. Now, according to the preceding experiment, the carriage fell 25 feet in 18 seconds; 71·9 in 28 seconds: and 124·6 in 38 seconds: Therefore,

In open atmosphere. In vacuo.

$$71{\cdot}9 \div 25 = 2{\cdot}876, \text{ and } \frac{12608{\cdot}072}{5210{\cdot}892} = 2{\cdot}419.$$

Again, omitting fractions,

In open air. In vacuo.

$$124 \div 71 = 1{\cdot}746, \text{ and } \frac{23224}{12608} = 1{\cdot}842.$$

Again, to make the proof more indisputable (relying upon the measurement of Mr. Wood), we find that, according to his experiments, the carriage descended, omitting fractions, 25 feet in 18 seconds, and 1266 feet in 128 seconds. Now, as before observed, a body would fall, in vacuo, in 18 seconds, about 5211 feet, because 18×18×16·083=to the total space; and in 128 seconds it would fall 263508·672 feet.

Now 1266÷25 (in air)=50·64;
and 263508÷5211 (in vacuo)=50·56.

How very striking, then, is the proportion which the falling body bears in vacuo to the descending body, when opposed to the resist-

ance of the air! So much so, that Mr. Wood must either have imposed upon the public, which I do not and cannot believe, or his experiments, though not intended to elucidate the theory of resistance, are a death-blow to the previously admitted opinions on this subject.

Again, referring to Mr. Wood's experiments (see page 225), we find a perfect regularity in the descending motions; for instance, the carriage was 29·16 seconds in moving 100 feet, and 58·33 in descending 400 feet.

In other instances:

Time in descending 100 feet.	Time in descending 400 feet.
29·10 seconds	58·10
30	60·41
29·16	58·75
31·95	64·35

and all with different loads, varying from 1,120 to 8,960 lbs.

Again, page 226, when the carriage was loaded with 8,960 lbs. it fell 100 feet in 29 seconds, and 400 feet in 58.

Again, in 29 seconds it fell 57·90 feet.
Again, 29·10 " " 58·40 "
Again, 29·74 " " 60·25 "
Again, 31·88 " " 63·75 "
the weights varying as before.

We will next observe whether the proportions were regular. In doing this we find (page 225) that the carriage, with a load of 1,120 lbs. fell 200 feet in 45 seconds, and 300 feet in 55 seconds. Now, in vacuo, a body would *fall* in

45 seconds - - - 32568·075 feet,
and in 55 seconds - - - 48651·075 feet.

Now 300 — $\frac{1}{3}$ = 200, the fall in 45 seconds on the inclined plane; and 48651 — $\frac{1}{3}$ = 32434, showing a difference of only 134 in about 32,000.

In another experiment, with 4,480 lbs., the carriage fell 400 feet in 60·41 seconds, and 500 feet in 67·91 seconds.

Now, in vacuo, a body would fall in
60·41 seconds, 58512·7871523 feet;
and in 67·91 " 74315·8133523 "
therefore, 400+$\frac{1}{4}$=500
58512+$\frac{1}{4}$=73140, showing a difference in comparative velocity not worth noticing.

Again, with 1120 lbs., in which instance, owing to the lighter weight, the resistance of the air ought to have been the most felt, we find the body descending,

In 64·35 seconds, 400 feet
72·64 " 500 "
Now 400+$\frac{1}{4}$=500, and
66958+$\frac{1}{4}$=83247, showing a difference which is altogether immaterial; for had the distance traversed been 400 and 510 feet, instead of 400 and 500, the proportions *in vacuo* and in open atmosphere would have been precisely alike. Surely, then, these 10 *feet*, considering the variation of friction, by the occasional rubbing of the flanches against the rail, will be regarded as a difference altogether independent of the resistance of air!

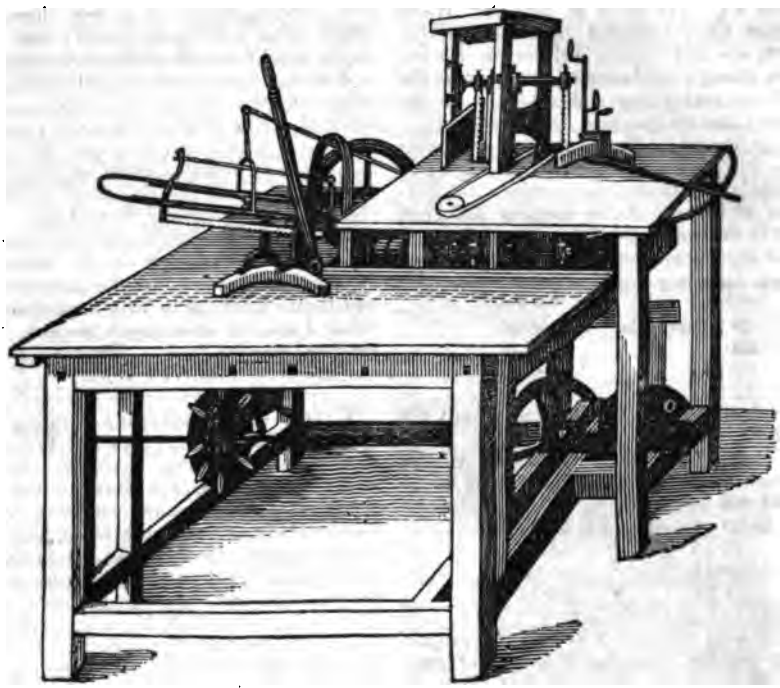
There are many more experiments of Mr. Wood's to which I could have referred in support of my opinion. It is true there are some which show a different result; but the effect might arise from the different state of the rails at different times, and the particular point from which the wind blew. It cannot, however, be doubted, or, if doubted, denied, that the uniformity of acceleration, proved by the experiments herein detailed, *could not have occurred in any instance had the resistance of the air increased as the squares of the velocity.*

I shall, in a further communication, turn to my recent experiments on the Liverpool and Manchester railway, for the purpose of adding additional strength to this argument. Meanwhile I am, sir, with much respect, your very obedient servant, RICHARD BADNALL.

Manchester, Nov. 11, 1833.

CAUSES OF INDIGESTION.—Among the chief causes of indigestion (says Dr. Wilson Philip, in his treatise on this disease,) which act directly on the muscular fibres of the stomach, are narcotic and other offensive substances received into it. I have found that although opium applied to the external surface of the alimentary canal and heart produces no sensible effect on their muscular power, applied to their internal surface, it produces the same effect as when directly applied to the muscular fibres themselves, impairing their power, unless the quantity be extremely minute, and instantly destroying it if the quantity be considerable. It is probable that other offensive substances acting on the stomach—tobacco, distilled spirits, strong peppers, those of an acrid or putrid nature generated in the stomach itself, &c., may also in the same way immediately affect the muscular fibres. It is not uncommon for a fit of indigestion to be induced by taking suddenly considerable quantities of iced fluids. Violent and repeated vomiting also debilitates the muscular fibres of the stomach. But of the causes which immediately affect them, the most frequent and powerful is morbid distention, the most common cause of which is eating too fast; another frequent cause being high seasoning and great variety of food, or such as particularly pleases the palate, by which we are induced to eat after the appetite is satisfied.

FEMALE SUPREMACY.—By all external symptoms, says an amusing writer in this month's Metropolitan, we may apprehend that the reign of women is fast approaching: look at the present aspect of Europe; a Queen of Spain, a Queen of Portugal, a prospective Queen of England. So that we are, at last, to be duly brought under "petticoat government." There is, too, Mrs. Norton conducting a magazine, and Mrs. Cornwall Wilson a weekly publication. Have not women invaded literature and art in all its branches—nay, the most awful arcana of science? There is Mrs. Somerville teaching us the mechanism of the heavens; while Miss Harriet Martineau gives us lessons on political economy.—[London paper.]



Hamilton's Sawing and Boring Machine.—This machine is designed for sawing and boring wood or timber, and is claimed by Colonel Hamilton in his specification to be "*an improvement in the mode of sawing felloes of wheels, circular and curved segments,* mitre joints, tenons, and also boring of felloes and hubs of wheels;" and generally for sawing circular, curved, and plain surfaces.

The machine is propelled by a two horse power steam engine. Animal or water power may be applied for the same purpose. The particular form required is sawed out of the timber with perfect accuracy and great expedition, by means of one or more thin narrow saws moving up and down. There is also belonging to this machine a horizontal saw for cutting segments of circles their proper lengths, and with proper inclinations for joints, tenons, &c. &c. Hubs of carriages are bored with perfect precision. All these operations are effected by the changing position of the material, accommodating itself as it comes in contact with the saw or auger, so as to receive the exact form, inclination, &c. required. Every thing is done, without marking or laying out, with mathematical accuracy by means of scales, which are distinctly laid down on the machine.

The machinery which guides and steadies the material in its movements may be readily varied, so as to form segments of wheels of greater or less dimensions; and the boring may also be more or less inclined. The scale indicates the exact position which the part of the machine that guides the material required to form a wheel,—for instance, of greater or less circumference. Slats and legs of chairs may be made of various lengths, and thicknesses, and shapes, as fashion or utility may dictate.

This machine affords a happy specimen of labor saving, and may be advantageously applied to a variety of useful purposes. It occupies but little space, only a part of a small room. No skill is required in using it. A mere laborer, or a boy, can learn in a few hours to use the machine, and to produce the article as perfect as the most skilful machinist. Like many other labor saving machines, it performs that part of the labor which the accuracy and strength of the human hand are incompetent rapidly, and with precision, to perform; it, in fact, does the work which is the most difficult and toilsome to the laboring manufacturer.

The expedition with which materials of small value, and with very little waste, are converted into articles of comparatively much greater value is entitled to particular notice. Chair backs sawed from our native curled maple are worth from *eight to twelve and a half dollars* per hundred.

By the aid of this machine, which costs only about *three hundred dollars*, a common

laborer may do the work of twenty or thirty mechanics. The merit claimed by Colonel Hamilton consists chiefly in the facility and accuracy with which the material is adapted to the saw, so as expeditiously and uniformly to produce the exact form which is wanted.

A Compendium of Civil Architecture, arranged in Questions and Answers, with Notes, embracing History, the Classics, and the Early Arts, &c. By Robert Brindley, Architect, Surveyor, and Engineer. [Continued from page 181.]

NORMAN STYLE.

Q. What is to be said of the Norman architecture?

A. The rich Norman Barons, after the conquest, began to build magnificent castles and churches, introducing architecture on an extended scale, and in a style peculiar to themselves.

Q. How long did the Norman style prevail?

A. To the end of Henry VI. 1189. It seems rather to have commenced before the conquest, but there are no attesting remains.

Q. What is the criterion in determining Norman architecture?

A. This style, as well as the three subsequent ones, may be divided into the following sections: namely, doors, windows, arches, piers, buttresses, tablets, niches, ornamental carvings, and steeples.

Q. How is the Norman door distinguished?

A. The arch is semi-circular; on which are a vast number of bands and mouldings, which increase the depth, and give great richness. Shafts are often used, though sometimes one door is decorated and the other not. An impost moulding surmounts the shaft before the arch moulding springs. These mouldings are much ornamented. The wave and zigzag ornaments are universal, as is also the beak-headed moulding.

Q. How far does the external moulding of the arch extend?

A. No lower than the spring of the arch. In resemblance it is a dripstone, though not projecting as such.

Q. Of what shape is the door?

A. The door is often square, and deeply recessed; the internal part of the arch being ornamented. Iffley church, near Oxford, affords very fine specimens of Norman doors, having three, and all different. Durham, Rochester, Worcester, and Lincoln cathedrals, have also very fine doors. The ornaments are all external; the insides quite flush.

Q. Of what description are the windows?

A. Very diminutive. In large buildings shafts are frequently used. There are no mullions. The arch is semi-circular, and the aperture splays both internally and externally. The bottom is horizontal. There is no attempt to feathering either doors or windows. Kirstall Abbey has all its work exteriorly round arches, though the nave has pointed. There are a few horse-shoe arches and double arches introduced, some with plain faces, but mostly ornamented with the zigzag.

Q. What of the Norman piers?

A. They are of four descriptions: 1st, the *round massive column pier*, having sometimes a round, and sometimes a square capital—plain, or with channels in various forms. It is found from two to six or seven diameters high. The square headed capital is generally the tallest. 2d, a *multangular pier*, less massive, used octagonal and common, with an arch more or less pointed. 3d, *a common pier*, with shafts; this has a square capital, but much ornamented with foliage. The shafts are mostly set in square recesses. 4th, a *plain pier*, with plain round arches in two or three divisions. In some cases shafts are divided by bands.

Q. Describe the Norman buttresses?

A. They have plain broad faces with small projections running up to the cornice tablet, sometimes finishing with a slope, and, in a few instances, composed of several shafts.

Q. What of the Norman tablets?

A. The tablet usually called the cornice is frequently only a plain face of a parapet, projecting the same as the buttresses; but under is placed a row of blocks, either plain or carved in grotesque heads; a plain string is also used as a cornice.

Q. What is the next tablet?

A. This is the dripstone, or outer moulding of windows and doors. It is sometimes undistinguished; oftener a plain round or square string, continued horizontally from one window to another round the buttresses.

Q. What of the other tablets under windows?

A. They are generally plain slopes above and below a flat string. In the interior, and sometimes the exterior, these are much carved in devices.

Q. What are the Norman niches?

A. They are a series of small arches, with round or intersecting arches, sometimes without, but oftener with shafts. Some have their mouldings ornamented.

Q. Name the Norman ornaments.

A. The first and most frequent is the zigzag or cheveron moulding, used in great profusion; and the second is the beak-head on doors, consisting of a hollow, and large round.

Q. What is the Norman steeple?

A. A massive tower, seldom rising more than a square above the roof. It is sometimes plain, but mostly ornamented by plain or intersecting arches, and has the flat buttress. That of St. Albans runs into a round turret, at each corner of the upper stage.

Q. Are the Norman steeples crowned with pinnacles?

A. No; but there are some turrets crowned with large pinnacles, which may be Norman. Such is at Cleve, in Gloucestershire; and such was one of the towers at the side of the west front of Rochester cathedral, which has lately undergone a complete change in repairs.

EARLY ENGLISH STYLE.

Note.—The early English and subsequent styles are frequently confounded with the Gothic, by the appellation of *modern Gothic*, and certainly very improperly. The classification of styles handed down to us decidedly demonstrate the error. This appellation was first bestowed by the Italians on some species of ecclesiastical architecture, as an epithet of obloquy, "*La manera Gotica*," signifying its supposed barbarous derivation from the Grecian or Roman models—not implying its procedure from the Goths; who possessed no *national* style of architecture, and who, when in Italy, profited by Italian artists.

The most correct term would be *Saracenic*. Wren was of this opinion, attributing its refinement to the Christians, after the fall of the Grecian empire. Salisbury Cathedral Church, finished in 1258, is entirely Saracenic.

About the time of Henry II. the English language was formed, the nation assuming a new character; and architecture, founded on the Norman and Saxon, yet differing from both, was invented by the English monks, whose abilities were most strenuously exercised in the work, on construction peculiar to themselves. Is it not just, therefore, to distinguish this style as English, the Gothic being applied, indiscriminately, to all edifices differing from the Grecian and Roman?

Q. Whence the early English style?

A. The introduction of shafts instead of such massive piers, and a higher mode of building, together with the pointed arch. An increased delicacy of execution and boldness of composition mark the dawn of this simple yet beautiful style, at the close of the twelfth century, reaching to the end of Edward I. 1307.

Q. What then may be advanced about the early English doors?

A. They are all pointed, at least exterior ornamented ones. There are small interior doors, with flat tops, and the sides of the tops supported by a quarter circle on each side. The large doors are mostly double, divided either by one shaft or several clustered, with a quatrefoil or other ornament over them. These doors are recessed as the Norman—bands and shafts more numerous—with hollow mouldings enriched with a peculiar ornament of this style, a *toothed projection*; but there are many doors perfectly plain. The door at Christ Church, Hants, is a fine specimen.

Q. What of the mouldings and ornaments of these doors?

A. The dripstone is clearly marked—small, and supported by a head. In many doors a trefoil and cinquefoil feathering is used. The principal moulding is an equilateral arch; but from the number of additional mouldings, the exterior becomes nearly a semicircle. Some doors have trefoil arches, shafts (round, sometimes filtered,) standing in a hollow moulding, with a variety of capitals—many plain, and many with delicate leaves running up and curling round under the cap moulding, like Ionic volutes. The bases are numerous—a plain round fillet, and the reversed ogee frequently used—mouldings cut with great boldness. York, Lincoln, and Chichester, have very fine specimens of these doors.

Q. Describe the early English windows?

A. They are narrow and lancet headed, without feathering—in some instances trefoiled. From this single shape a variety of appearance results from their combination.

Q. What is the appearance?

A. Where there are two, there is often a trefoil or quatrefoil between the heads, and divided by so small a division as to give the appearance of one large window, though in reality they are separate, having their heads from individual centres and separate dripstones. Westminster affords an example of this.

Q. What are the ornaments of these windows in large buildings?

A. Frequently they are ornamented with long and slender shafts, *banded*. There is, in all long windows of this style, one almost universal distinction, at the straight side of the window opening, by a shaft being added which is mostly insular, seldom having connection with the side, and breaking into faces, though the shafts are inserted into the sides of the doors, so as to give great variety to these openings.

Q. What is the character of the early English arch?

A. *Lancet-headed*. Composition lancet arches are used in Henry VII.'s Chapel, Westminster, and at Bath; and *flat segmental* arches in the early English part of York. The architraves of large arches, to rich buildings, are beautifully moulded like the doors, with deep hollow mouldings, *toothed*. York transept, and the nave and transept of Lincoln, are beautiful specimens.

Q. What are the distinguishing features of the early English piers?

A. There are two: 1st, the constant division of the shafts, which compose them, by one or more bands in their length; 2d, by their being ranged circular round the centre. From four to eight are set round a large circular one, as at Salisbury and Westminster. Sometimes they are so numerous as nearly to hide the shaft.

Q. Of what description are the capitals?

A. They are several, consisting of a bell with a single or double annulet under it, and a sort of copying, with more annulets above. The dividing bands are also formed of annulets and fillets, often continued under windows. The bases approach to the Grecian attic; but the reversed ogee is used.

Q. How many descriptions of early English buttresses are there?

A. Four: 1st, the old Norman, though not always so broad, and its tablets more delicate; 2d, a buttress not so broad as the flat one, but nearly the same projection as breadth, and carried up sometimes with only one set-off, and sometimes without any. These have their edges often chamferred from the window-tablet. They have a shaft in the corner, and, in large rich buildings, are occasionally panelled. 3d, a long slender buttress of narrow face and great projection, in few stages, as used in some turrets, but not very common. 4th, towards the latter part of this style, the buttress in stages was used, though not very commonly; and is distinguished by its triangular head.

Q. What may be said of the early English tablets?

A. The cornice is rich in mouldings; often with an upper slope, making the face of the parapet perpendicular to the wall below. The dripstone is diversified with several mouldings, or round, with a small hollow, occasionally ornamented with the toothed ornament or flowers. In a few buildings the dripstone is returned, and runs as a tablet along the walls—generally narrow, supported by a corbel, either a head or flower. In large buildings there are, in the ornamented parts, bands of trefoils. The tablets forming the base mouldings are sometimes of a mere slope, at others are several sets of mouldings.

Q. What of the niches?

A. The most important are found in chancels. They are various—plain, trefoil-headed, and ornamented with shafts.

Q. Describe the ornaments.

A. They will be found in regular progression, from the Norman zigzag to the delicate four-leaved flowers. Another ornament is the filling of the spaces above the choir arches with squares enclosing four-leaved flowers. In the spandrills are circles filled with trefoils, &c. Crockets were not used, and the finial was a plain bunch of three or four leaves—sometimes a knob.

Q. What is the character of the towers?

A. They rose to a much greater height than the Norman, and on them were placed the most beautiful spires. Salisbury and Chichester stand unrivalled.

DECORATED ENGLISH STYLE.

Q. Where is the marked difference in this style and the former?

A. Principally in the alterations of the windows, by throwing them into large ones, divided by mullions; introducing tracery into the heads of them, and the use of flowered ornaments, together with the alterations in the piers.

Q. How far did this style extend?

A. To the end of Edward III., 1377; perhaps 18 or 20 years longer.

Q. What is the description of the doors?

A. They are in general single; some, however, are double, often with moulded buttresses placed on each side. These doors are nearly as large as the early English double, and in ornaments much resemble them. They are almost as deeply recessed as the Norman.

Q. What of the shafts and other parts?

A. The shafts do not stand free, but are parts of the sweeps of mouldings, and instead of being cut and set up lengthwise, all the mouldings are cut on the archstone, combining strength with elegance. The capitals are formed of woven leaves in foliage; the bases consist mostly of the reversed ogee. Over the doors are canopies. The dripstone is supported by a corbel, commonly a head.

Q. What of the canopies?

A. There are three.

Q. The first?

A. The first is a common canopy of a triangular shape; the space intermediate, and the dripstone, is filled with tracery. The exterior ornaments are crockets crowned with a finial.

Q. What of the second?

A. This canopy is the ogee, running halfway up the dripstone, and then turning the contrary way, finished with a straight line running into a finial.

Q. The third?

A. This canopy is an arch running over the door, and unconnected with it, which is doubly foliated.

Q. What is to be advanced about the decorated windows?

A. They are several, although of one

principle. An arch is divided by one or more mullions, and these branch into tracery. The windows are divided into from two to nine lights.

Q. What descriptions of tracery are there?

A. Two; the first, the trefoils are all worked in the same moulding. The nave of York, the choir of Lincoln, Westminster Abbey, and Exeter, afford fine specimens. The second is the *flowing tracery*, as at York, St. Mary's, at Beverly, and other churches. In these windows large wheels are introduced; the principal moulding of the mullion has sometimes a capital and a base, and thus becomes a shaft. The architraves are not much ornamented; the dripstones and canopies are similar to those of the doors.

Q. What of the decorated English arches?

A. Those most commonly used are equilateral, but there are instances of the drop arch; the mouldings are of the last style. The dripstones are delicate mouldings, supported by heads. The arches of galleries are ornamented with foliated heads and fine canopies.

Q. What point most decidedly marks this era of architecture?

A. A new disposition of shafts being arranged diamond-wise, with straight sides, often containing as many shafts as will stand close to each other at the capital, and only a fillet or small hollow between them. The shaft which runs to support the roof often springs from a rich corbel. Exeter illustrates this beautiful style. The capital and bases are the same as described in the doors.

Q. Are there any more piers?

A. Yes; one at York Minster, where the centre shaft is larger than those on each side, and another pier, common towards the end of this style, is composed of four shafts, two-fifths engaged, and a fillet and bold hollow, half as large as the shaft, between each.

Q. Describe the decorated buttresses?

A. They are worked in stages, the setts-off being severally ornamented in moulded slopes, triangular heads, and panels. The common buttresses are frequently set diagonally, the whole differently finished.

Q. How are the tablets distinguished?

A. The cornice is very regular, with several mouldings; it principally consists of a slope above, and a deep sunk hollow, with an astragal under it. In these hollows, flowers, at regular distances, are placed; the dripstones are of the same description of mouldings, as also the tablets under the windows. The dripstones seldom run horizontal. The basement tablets are very numerous.

Q. What may be said of the niches?

A. They form one of the greatest beauties of the style, and are many, but may be divided into two grand divisions: First, the pannelled niches, the fronts of whose canopies are even with the face of the walls in which they are set; the interiors are either square, with a sloping side, or are regular semi-hexagons, and the pedestals much ornamented. The second division of niches have projecting canopies of several shapes, and are equally as ornamented.

Q. What of the ornamental parts of this style?

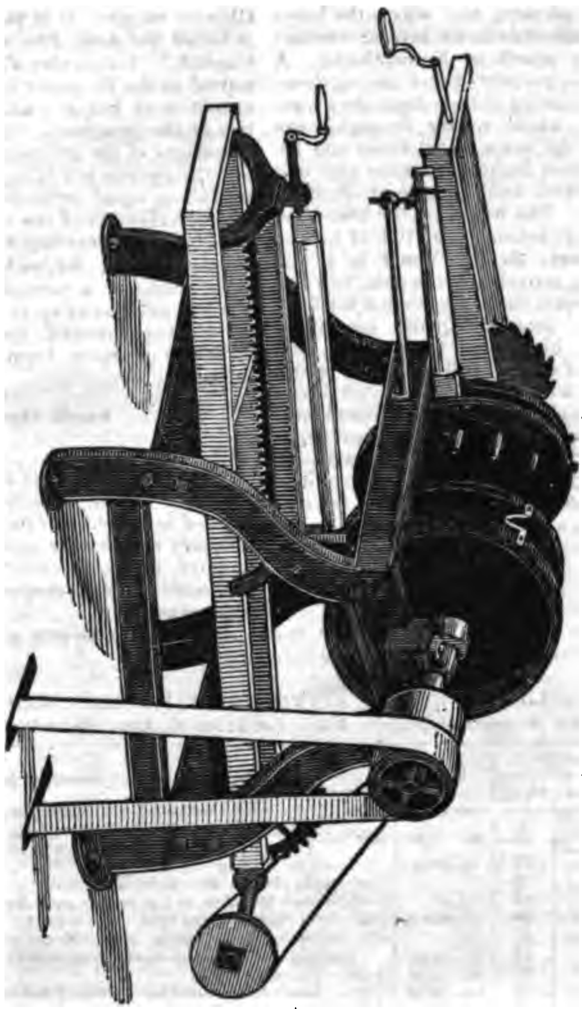
A. The doors, &c. already described sufficiently establish its distinguishing features from the more early style, and impress the mind with its beauties.

Q. What of the steeples?

A. They are on the principle of the former style, with more profuse decorations. The spires throughout Lincolnshire are very fine.

Resistance of Fluids to Bodies passing through them.—The following notice has recently appeared of a paper entitled "An Account of a Second Series of Experiments on the Resistance of Fluids to Bodies passing through them," by James Walker, Esq. F. R. S. Civil Engineer; which was read before the Royal Society on June 6th, 1833.

The author, in a paper read to the Society in the year 1827, and printed in the Philosophical Transactions, gave an account of some experiments showing that the resistance of fluids increases in a ratio considerably higher than the square of the velocity, and that the absolute resistance is smaller than had been deduced from the experiments of the French Academy. In the present communication he states the results of his further inquiries on this subject. His experiments were made at the East India Docks, on a boat twenty-three feet long and six wide, with a stem and stern nearly vertical; one end being terminated by an angle of forty-two degrees, and the other of seventy-two degrees; and the resistance to the boat's motion being measured by a dynamometer. The results are given in tables; and it appears from them that in light vessels sharpness is more important in the bow than in the stern; but that the reverse is the case in vessels carrying heavy cargoes. From another series of experiments the author infers that the resistance to a flat surface does not exceed 1·25 lb. for each square foot, at a speed of one mile per hour; increasing for greater velocities, in a ratio considerably higher than the square of the velocity. The author concludes with some observations on the results lately obtained in Scotland, where great velocities were given to boats moving on canals, without a proportional increase of resistance.—[Proceedings of Royal Society.]



Wiswall's Yoke Cutter for dressing Spokes of Wheels.—By means of a circular saw operating in connection with the cutter wheels, the timber is squared and cut to any length that may be required, and the tenons of the spokes are then formed of any required dimensions. The spoke being presented to the action of the first cutter, or tenon wheel, by hand, the tenon is formed in less than a minute, and the body of the spoke is dressed into shape and smoothly finished, first on one side and then on the other, by two operations, in another minute, more perfectly than it could be by any mere hand tool, though used by the nicest operator. No means of forming the round tenon which is to be inserted in the rim was exhibited. This, it is obvious, must be effected by a fourth operation. The whole machine is evidently capable of a more perfect construction than that examined by the committee; but such as was exhibited in operation is evidently a useful improvement, and a labor saving machine of great profit. It saves all the time which an operator by hand necessarily expends in judging by his eye of the exactness of the shape given, and to be gained by his tool, and may be operated in artificial light, when the laborer by hand would be scarcely able to judge of his own work. There is therefore much gained by the art of making wheels, which artists in that branch of mechanics will find profitable to themselves, as they can employ their journeymen more usefully on other parts of the wheel, and in adjusting them to each other.

Blindness of Passion, or Mistakes of a Kamtschatkan Bear.—Fish, which forms

their chief nourishment, and which the bears procure for themselves in the rivers, was last year excessively scarce in Kamtschatka. A great famine consequently existed among them, and, instead of retiring to their dens, they wandered about the whole winter through, even in the streets of the town of St. Peter and St. Paul. One of them finding the outer gate of a house open, entered, and the gate accidentally closed after him. The woman of the house had just placed a large tea-machine, full of boiling water, in the court: the bear smelt to it and burned his nose; provoked at the pain, he vented all his fury upon the kettle, folded his fore-paws round it, pressed it with his whole strength against his breast to crush it, and burned himself, of course, still more and more. The horrible growl which rage and pain forced from him brought all the inhabitants of the house and neighborhood to the spot, and poor bruin was soon dispatched by shots from the window. He has, however, immortalized his memory, and become a proverb amongst the town's-people, for, when any one injures himself by his own violence, they call him "the bear with the tea-kettle."—[Capt. Kotzebue's New Voyages round the World in the Years 1823–1826.]

The Press in China.—There is but one journal in the Chinese language in the whole Chinese empire; it is published at Pekin, and is called the *King Pao*, or "Messenger of the Capital." It contains all the ordinances submitted to the Emperor for approval by the six ministers of Pekin, and the various authorities of the provinces, as well as by the commandants of the military corps. The amount of subscription is a liang and an ounce of silver (about equal to twelve francs) per annum. The inhabitants of the capital alone have the advantage of receiving the paper every day at a regular hour; for, as China has no such establishment as a post-office, the country subscribers get their papers only as occasion may favor; consequently, those living at a considerable distance from the capital receive them very irregularly.

Avoylle Ferry, on Red River, Lou.,
February 8th, 1834.

To the Editor:

Sir—Inclosed is the range of the Thermometer for the month of January, regularly entered as stated. It has been the most extraordinary month ever noticed in this part of the country, for cold—cloudy—rains—and changes of weather. Most respectfully, your most obedient servant, P. G. Voorhies.

P. S.—I wrote you particularly on 3d January, ultimo.

METEOROLOGICAL RECORD, KEPT AT AVOYLLE FERRY, RED RIVER, LOU.

For the month of January, 1834—(*Lat.* 31.10 *N.*, *Long.* 91.59 *W. nearly.*)

Date. 1834.	*Thermometer.* Morn'g.	Noon.	Night.	*Wind.*	*Weather, Remarks, &c.*
Jan'ry 1	51	54	53	NE—light	cloudy—{distant heavy thunder a. m.—at 4 p. m. a severe thunder shower from S to W—at 7 p. m. wind W to N—high all night
" 2	34	36	33	N—high	" —wind high all day and night
" 3	22	34	32	"	clear—night cloudy—Red River at a stand
" 4	26	26	24	N	cloudy—snow at 9 a. m. to 1 p. m., one inch deep—night clear
" 5	16	30	28	calm	clear—light clouds—night clear—severe freeze
" 6	24	38	35	"	" —snow left in the shade, where the the sun shone all gone
" 7	21	45	44	S—light	" morning—white frost—snow gone—evening and night cloudy—Red River rising
" 8	42	52	50	NE—light	cloudy—pumpkins froze
" 9	46	50	66	SE—light	" —heavy thunder and rain—evening and night drizzling, steady
" 10	56	73	70	"	" —showers all day and night
" 11	69	76	72	S	" " " "
" 12	67	64	54	NW—high	" " a. m —evening clear—wind N, high
" 13	39	43	42	N	" " all day—and all night drizzling
" 14	38	42	39	calm	" " " " "
" 15	42	50	54	"	" " " " "
" 16	58	64	63	S—light	" " " " "
" 17	65	71	70	"	" " some sunshine " "
" 18	68	73	68	"	" " " " "
" 19	67	72	70	calm	" " " " "
" 20	66	71	72	"	" —foggy morning—evening light clouds and sunshine
" 21	50	49	41	N—high	" —light rain or drizzling all day and night
" 22	36	45	43	N—light	" " " " "
" 23	39	47	46	calm	" " " " "
" 24	42	46	45	"	" " " " "
" 25	48	68	70	"	" " evening light clouds, and wind S, light
" 26	59	53	51	NE	" "
" 27	37	33	36	"	" —rain all day, with some hail—and night hail and sleet
" 28	32	35	34	N	" —snowing light all day—and drizzling and hail all night
" 29	[illegible]	[illegible]	37	calm	" " " " " " "
" 30	38	54	54	"	" evening, sun visible through light clouds
" 31	40	44	42	W—high	" " sunshine and night clear

Red River rose this month 3 feet 5 inches—below high water, 7 feet 9 inches

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York—in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 25 cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*. John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

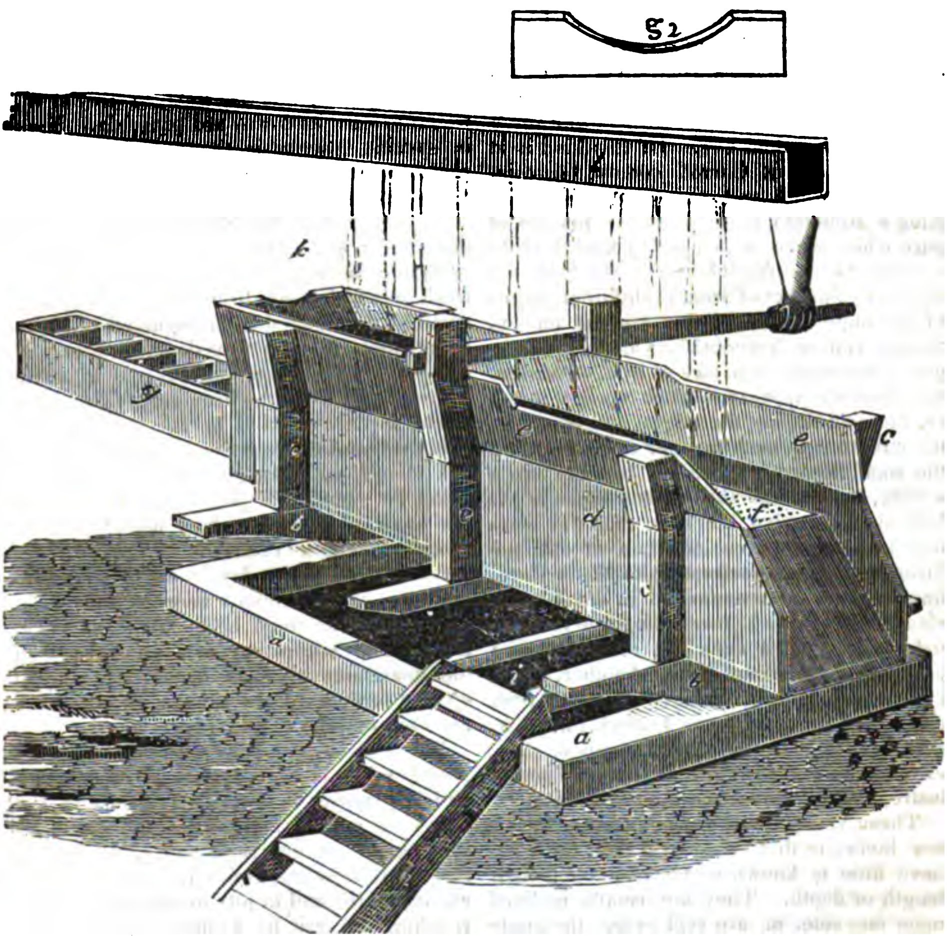
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FOR THE WEEK ENDING APRIL 19, 1834. [NUMBER 4.

"Knowledge is power."



G. B. Palmer's Gold Washing Machine. By J. STICKNEY. To the Editor of the Mechanics' Magazine.

DEAR SIR,—Accompanying this rude sketch of a Gold-Washing Machine I also send you a few remarks, which, from various circumstances, will of necessity be still more crude and hasty.

REFERENCES.—*a a*, parts of a horizontal frame, 5 feet long, 3 wide; *b b*, rockers supporting the trunk of the machine; *c c c*, posts inclosing the trunk; *d*, trunk in which the rippler is secured, 7 feet long; *e e*, sloping sides of the box; *f*, cast iron plates, 5 fee long, 15 inches wide; *g*, the rippler, partly drawn out; *h*, outside rippler, stationary; *i*, a box, conveying the water to the outside rippler; *k*, the head, or feeding place; *l*, water conductor. The rockers are shod, and stand on plates of iron; a bolt fixed in the sil passes into a hole in the centre of each, to keep them from slipping. The sill of the centre frame, (to which is fastened the handle,) continues beyond the post, and, when

the machine is in operation, beats upon two irons on the lower frame, to give motion to its contents. When washing, the rippler is locked up in the body of the trunk, and not seen; the true form of its partitions is seen at *g* 2. The machine is "fed" at *k*, and the stones, &c. discharged at the sloping end; the gold and sand having passed through the plate, *f*, into the rippler which contains mercury, if any gold escapes the first ripple it is supposed to be caught in the one outside.

The gold mines of this country may be divided into those of *vein*, *surface*, and *deposite*. The first have a great diversity of appearance; in some of them the gold is imbedded in pure white quartz rock, and often visible to the naked eye. Of this kind is at least one vein at Carroll county, Georgia. Others in white and red sand stone, (the King's Mountain mine possesses masses of pure white stone, which is so friable as to crumble to fine sand between the fingers;) some in sulphuret of iron, in different stages of decomposition, (of this kind is an extensive vein at Narcoochly Valley, in Georgia;) others in the oxides of iron, or ochres. Sometimes it appears in dark spongy masses, the gold tipping the edges, and points of the structure in such manner as to resemble the small flowers of lichens. In some mines a dark, porous, and vitrious substance is exhibited, impressing the idea that the mass had been suddenly cooled when in extreme fusion. In one specimen from South Carolina the gold is disseminated in small particles through a rock, resembling fine variegated marble; as it does not contain lime, I presume it a species of slate. Another, which I obtained at the celebrated Duncan vein, (No. 1052 of the Georgia Lottery,) has particles of rich gold embedded in strata of slate, or rather of slaty structure, unctuous, of pearly lustre, and somewhat resembling stratite.

These veins are of various widths, from a few inches to that of several feet, but I believe little is known as yet respecting their length or depth. They are usually inclined upon one side, or are said to dip, the angle of which varies from that of nearly a vertical position, to more than 45°.

In places where the soil has been washed from the sides of hills, these veins of quartz, of various sizes, are seen traversing the micaceous slate, or gneis, and, as it may be presumed that some of these small as well as large ones contain gold, it may not be unreasonable to account for the *surface* and *deposite* mines, by supposing it to be disintegrated from its natural bed by the effects of frosts, atmosphere, water, &c. Veins thus broken down, and the gold disengaged, will constitute what is called *a surface mine;* one of this kind before the door of a neighboring dwelling is now being operated upon, worth from two to three dollars per hand, per day, which has been trodden under foot for thirty years. From these *surface mines* the gold (being assisted by every shower that forms a rill) finds its way to the beds of the streams, and is deposited as soon as the gravity of each particle overcomes the force by which it is impelled forward; being heavier than other substances, and by the constant changing of the beds of the streams, and other causes, it finds the lowest situation in the deposite, that is, next to the slate, which arrests its downward progress. Next in specific gravity is the quartz and iron rocks, which are also found resting on the slate, and are covered by various strata of other soils, from the depth of from one to thirty feet; and as the constant deposition of gold may be supposed to be going on by fresh accumulations from the surface, and particles disengaged from fragments of rocks by attrition, in their way downward, and as the progress of these *particles* is in some degree impeded by the firmness of this quartz strata, we are enabled to account for their being diffused through this mass generally.

I should not thus gravely attempt to account for "*gold in deposite,*" was it not that we have philosophers who assert that it *grows*—that new creations of the precious metal are afforded "day by day;" and others, that those streams *were its natal beds*, and it has remained here since the creation; while others say that an eruption of the mountains at some distant period had ejected forth a golden shower, of which we are now reaping the harvest.

The first object of the operator on a deposite mine is to ascertain its value, for which purpose he usually proceeds in the following manner: He finds the depth of the "grit," or quartz deposite, by forcing down a slender iron rod. If not too deep, he excavates the soil in pits or ditches. When reaching the grit he washes a small quantity, and proceeding through that strata to the slate, tries it again by washing, and if from these results in several places he forms a favorable opinion, he sets about preparing the mine by cutting ditches for the streams, and others for draining the mine, which sometimes are necessary to be twelve or fourteen feet deep, and of great length. His supply of water for washing must be brought in in small canals six or eight feet above the surface of the mine, and often times the fountain must be sought a mile or two from the

place of operation. The next thing is to place his machine, or rockers, where they will be most convenient for the plan of his future operations; he then clears a pit ten feet wide, and from ten to one hundred and fifty yards in length. As soon, however, as a portion of the grit is laid bare, a number of the hands are employed in raising, and others in wheeling it in barrows to the machine, where one is employed to fill it, one to move it, one to cast away the cocks when washed, and perhaps another to keep the outside rippler clear from sand. The grit being placed in the machine, (which in some respects resembles a family cradle,) and agitated from side to side under the streams of falling water, washes the gold and sand through the cast iron plates into the inside rippler containing mercury, where, by the strong affinity or attraction which exists between the mercury and the gold, the latter is secured, while the sand is washed away. When the day's work is finished the rippler is drawn out, the gold in amalgam washed and secured, and the mercury expelled by heat. It is then sent to the refiners, where all foreign substances (silver excepted) are destroyed by the different agents employed in this fluxes, and (if correctly refined) valued accordingly, the quantity of silver in different mines is supposed to vary from two to forty per cent.

Machines of various constructions have been used in collecting the gold, but the one here represented has mostly taken the place of all others among regular miners. It was invented and patented about three years since by Mr. G. B. Palmer, of Spartanburgh, South Carolina, whose experience in mining enabled him to embrace in this simple form every requisite principle for effectually collecting the fine as well as coarse particles of gold. His price for rights amounts to a mere compensation for his expense and labor in perfecting his improvement.

We fear that the richest mines in this vicinity are mostly wrought out, and that we shall soon begin to feel the effects of the "*removal of the deposites.*"

Most respectfully, yours, &c.

J. Stickney.

History of Chemistry. [Continued from page 155.]

Of Copper.—Copper is one of those metals which were known in the most early ages of the world, and has at all times been one of the most easy to extract and manufacture. The Egyptians employed it for a variety of uses, and made of it cast figures, remarkable for their elegant form in the remotest times of their history. The Greeks manufactured it, melted it, cast it, and employed it in various arts. With them it made the base of the celebrated compounds called Corinthian Brass. The Romans likewise manufactured it in great quantities; and it has ever been imagined that the greater number of their utensils were always made with this metal, and very rarely with iron. This circumstance has been urged as a valid proof that they knew little of iron, and were unskilful in manufacturing it.

The alchemists employed themselves much about copper. They called it *Venus*, on account of the great facility it possesses of combining with many substances, particularly with other metals, and because of the sort of adulteration it makes in these compounds.

By representing it by the emblem appropriated to gold, terminated at bottom by the sign of a cross, they considered it as formed chiefly of gold, but disguised and altered by something acrid and corrosive, which rendered it crude. Though, in the different periods of the great revolution, which has changed the face of chemistry, we cannot find any researches concerning copper that are immediately connected with the annals of this revolution, or have served to lay the foundation of it, yet this metal holds a rank among those substances, of which the properties are better known, and the modifications have been more accurately determined, since the establishment of the pneumatic doctrine. In this class of properties, accurately explained by the modern theory, we ought particularly to place its different degrees of oxidation, its solutions in acids and in ammonia, its precipitates from the metallic state to its highest degree of oxidation, and its reduction by various processes. The labors of Berthollet, Guyton, and Proust, have particularly contributed to the accurate knowledge of these last mentioned facts. Our knowledge of this metal has also become much more complete, and the facts concerning it by far more simple, since the discoveries which have been lately made in experimental chemistry. It holds almost the third rank among metals in this respect. With regard to its elasticity, it holds nearly the same rank. Its ductility has led Guyton to place it in the sixth rank of metals, between tin and lead. It may be reduced into laminæ, or leaves extremely thin, which the wind will blow away. Its tenacity likewise is pretty considerable: a copper wire, one-tenth of an inch in diameter, supports a weight of 299¼ pounds, without breaking. Its strength or resistance to being broken is estimated by Wallerius as nearly equal to that of iron. Its sonorous

quality is superior to that of iron, as may be proved by wires of the two metals of equal length and thickness.

This metal is of a fine red color, and has a great deal of brilliancy. Its taste is styptic and nauseous; and the hands, when rubbed for some time on it, acquire a peculiar and disagreeable odor.

The density of copper is such, that its specific gravity is to that of water as 7·788 to 1·000. This gravity, however, varies according to the state of the metal: when it has only been melted and cast, it is less than when it has been hammered and forged; but after having passed through the mill, and been drawn into wire, it has the specific gravity of 8.878, which is an increase of about one-seventh.

Its power of conducting caloric has not been accurately ascertained, though it is known to be very great. It does not melt till it is very red. Its fusibility has been estimated by Mortimer at 1450 degrees of Fahrenheit's thermomether, and by Guyton at 27 degrees of the pyrometer of Wedgewood. When it is melted and cast into ingot moulds, that it may cool quickly, it assumes a granulous and porous texture, which shows like a kind of *crumb* in its fracture, and is liable to exhibit many cavities and flaws in its interior parts. If it be cooled slowly, it yields crystals in quadrangular pyramids, or in octahedrons, which arise from the cube, its primitive form. At a temperature above what is required for its fusion, it rises in vapor, and in a visible smoke, as is observed in places where this metal is cast in the large way, and in the chimneys over the furnaces.

Copper is a very good conductor of electricity and galvanism; but its order and power in this respect, compared with that of other metallic substances, has not yet been determined with precision. The acrid and somewhat fetid smell which pretty sensibly characterizes and distinguishes copper, is well known to every one. Rubbing the hand a little time on it is sufficient to impart this coppery odor, to which some other phenomena of the organ of smell have even been compared, particularly that of a *cold in the head.*

Copper is pretty abundantly diffused throughout nature. Germany, Sweden, and Siberia, however, are the three countries where it has hitherto been found in the largest quantity, and which furnish the most to commerce and the arts. The states of this metal in the earth are so various in their appearance, and in their physical properties, that mineralogists have singularly multiplied the species of it: some have admitted fifteen or twenty, though it is difficult to reckon nine or ten really different from each other in their nature. What they have taken for species are only varieties.

Native copper is met with pretty frequently in the interior parts of the earth, where it is even found very pure. It is known by its brilliancy, its red color, its ductility, and its specific gravity. Most commonly its surface is of an obscure dull and brown red, on account of the slight oxidation it has experienced. Sometimes it is found shining, and as if it had been burnished or polished; but this is much more rare than the preceding. Its form is frequently crystalline and regular; that of Siberia distinctly exhibits the cubic figure.

The places where native copper is most frequently observed are Siberia, Norberg, in Sweden, Newsol, in Hungary, and Saint-Bel, near Lyons.

Copper exposed to cold air, and particularly to damp air, soon loses its lustre; it tarnishes, becomes of a dull brown, grows gradually darker, acquires what is called the color of antique bronze, and at last becomes covered with a sort of green tint, tolerably bright, known to every one by the name of *verdigris*, or *verdet gris*, as the modern French chemists will have it.

The atmospheric oxygen begins by converting the surface of the metal into brown oxide; this oxidation is favored and accelerated by water. The carbonic acid soon unites itself with the copper thus oxidized; so that the kind of varnish of antique medals, statues, and utensils of various kinds, which antiquaries prize in them, and which they call *patine*, is nothing but a true super-oxygenated carbonate of copper, very analogous to malachite or mountain green.

This alteration of copper is much more powerful and rapid, if the temperature of the metal be increased. Every one may have observed how quickly the copper tunnels, used for carrying off the smoke of stoves, change their color from the moment they are first heated, even slightly, in contact with the air: they speedily assume a blueish, orange, yellowish, or brown tinge, which at length becomes wholly of an uniform deep brown over all the surface. These different and very beautiful hues are obtained even by cautiously exposing on burning coals thin plates or laminæ of copper, as well as that which is in light leaves. By this process, leaves of a sort of *foil* are made of various colors, which are chiefly used, after being cut into small pieces, for covering children's toys, to which they are fastened by a kind of

mordant or cement, previously applied on them. In fabricating these, the succession of blue, yellow, violet, and brown, may be observed; the last color too is that which remains, and is permanent.

When the action of fire on copper is strongly urged; when it is thrown, for instance, in the form of fine filings, into a very strong fire, or when it is heated in a crucible to a white heat after having been melted, it burns much more rapidly than in the former cases; it experiences a real conflagration; it even yields a very brilliant green flame. Accordingly, it is employed in the composition of the colored fires of the smaller kinds of fireworks, particularly those which are called table fire-works. The same effect which is perceptible at the surface of the crucible in which copper, thoroughly fused and very red, if melted and stirred, is produced by sending through this metal, in a small piece, or in wire, or in thin leaves, an electric discharge. It instantly emits a greenish flame, breaks with decrepitation, and is dispersed in smoke or dust in the air. It may be collected on paper, and will be found covered with a reddish brown oxide. It is to this property likewise we are indebted for the green color which we so frequently see in the flame of various combustible substances, but particularly alcohol, when cupreous salts have been dissolved in it. Notwithstanding the activity of this sort of combustion, and its difference from the slow oxidation already described, the oxide resulting from it uniformly contains but twenty-five parts of oxygen to a hundred of the metal, and completely resembles that which is obtained by the former kind of combustion.

We are yet ignorant of the union of copper with the first combustible substances; particularly with azote, hydrogen, and carbon, with which it is even believed to be incapable of combining. All we know is that hydrogen and carbon decompose the oxide of this metal, take from it its oxygen, and reduce it to the metallic state at a red heat.

Copper is capable of combining with most of the metals; and some of its alloys are of very great utility.

The alloy of gold and copper is easily formed by melting the two metals together. This alloy is much used, because copper has the property of increasing the hardness of gold, without injuring its color. Indeed, a little copper heightens the color of gold without diminishing its ductility. This alloy is more fusible than gold, and is therefore used as a solder for that precious metal. Copper increases likewise the hardness of gold. According to Muschenbroek, the hardness of this alloy is a maximum, when it is composed of seven parts of gold and one of copper. Gold alloyed with one-twelfth of pure copper, by Mr. Hatchett, was perfectly ductile, and of a fine yellow color, inclining to red. Its specific gravity was 17·157. This was below the mean. Hence the metals have suffered an expansion. Their bulk before union was 2782, after union 2798. So that 916⅔ of gold, and 83⅓ of copper, when united, instead of occupying the space of 1000, as would happen were there no expansion, become 1024.

Gold coin, sterling or standard gold, consists of pure gold alloyed with one-twelfth of some other metal. The metal used is always either copper or silver, or a mixture of both, as is most common in British coin. Now it appears that when gold is made standard by a mixture of equal weights of silver and copper, that the expansion is greater than when the copper alone is used, though the specific gravity of gold alloyed with silver differs but little from the mean. The specific gravity of gold alloyed with one-twenty-fourth of silver and one-twenty-fourth of copper was 17·344. The bulk of the metals before combination was 2700, after it, 2767.* We learn from the experiments of Mr. Hatchett, that our standard gold suffers less from friction than pure gold, or gold made standard by any other metal besides silver and copper; and that the stamp is not so liable to be obliterated as in pure gold. It therefore answers better for coin. A pound of standard gold is coined into 44½ guineas, or 46 $\frac{7}{40}$ sovereigns.

Platinum may be alloyed with copper by fusion, but a strong heat is necessary. The alloy is ductile, hard, takes a fine polish, and is not liable to tarnish. This alloy has been employed with advantage for composing the mirrors of reflecting telescopes. The platinum dilutes the color of the copper very much, and even destroys it unless it be used sparingly. For the experiments made upon it we are indebted to Dr. Lewis. Strauss has lately proposed a method of coating copper vessels with platinum instead of tin; it consists in rubbing an amalgam of platinum over the copper, and then exposing it to the proper heat.

Silver is easily alloyed with copper by fusion. The compound is harder and more sonorous than silver, and retains its white color even when the proportion of copper

---

* The first guineas coined were made standard by silver; afterwards copper was added to make up for the deficiency of the alloy; and as the proportion of silver and copper varies, the specific gravity of our gold coin is various also.

exceeds one half. The hardness is a maximum when the copper amounts to one-fifth of the silver. The standard or sterling silver of Britain, of which coin is made is a compound of 12½ silver and 1 copper. Its specific gravity after simple fusion, is 10·200. By calculation it should be 11·33. Hence it follows that the alloy expands, as is the case with gold when united to copper. A pound of standard silver is coined into 66 shillings.

Mercury acts but feebly upon copper, and does not dissolve it while cold; but if a small stream of melted copper be cautiously poured into mercury heated nearly to the boiling point, the two metals combine and form a soft white amalgam.

There is no metal more useful than copper, excepting iron, to which it yields the superiority. Every one knows that a great number of instruments and utensils are made of copper for various purposes. Those vessels which are to be placed upon the fire are generally made of it, as it is much less liable to alteration than iron, and at the same time much more easy to be wrought. Its alloys with zinc and tin are employed for a great number of purposes in the arts, and in common life. But unfortunately this medicine acts as a poison upon the animal economy; and it is one of the bodies that most threaten our existence. It is therefore much to be wished that it were proscribed, at least for economical and domestic uses. Cisterns, reservoirs, pipes, and cocks, made of this metal, or its alloys, are no less dangerous than copper pans; and frequently they are even more pernicious, as they are not kept with the same care as the vessels, the whole of which is exposed to view at once, and which are employed several times a day. Too much care, attention and prudence, cannot be employed in the use of all utensils made of copper, as all its oxides are extremely susceptible of dissolving in fat, oils, and most of the unctuous substances that are employed in the preparation of food. Frequent tinning is the most certain defence against this terrible evil.

Besides the varied and multiplied uses of copper in the metallic form, several ores and preparations of this metal are employed in a great number of the arts. The pyrites sulphurets serve for the preparation of the sulphuret of copper, by their spontaneous efflorescence and their lixiviation; it is also prepared by burning a mixture of sulphur and copper. The malachites are cut and polished for trinkets; copper is continually alloyed with zinc and tin for making brass, casting statues, bells, pieces of artillery, &c. Its different salts and oxides enter into the preparation of colors for painting; of the baths; the preparations and mordants for dyeing; of enamels and glazings for pottery and porcelain; and of colored glasses.

Of Iron.—Iron is the most important and most useful of all metallic substances. Without this metal no art could have arisen; man had remained in the savage state, and disputed for his food by brute strength with the other animals. Without this metal, agriculture could not have existed, nor could the plough have rendered the earth fertile. Without iron, all the other metals would have been of no utility; for it is by means of this agent that they receive their varied forms and dimensions. Iron alone may be considered as the representative of every other metal, and it may be substituted in the place of any of them; but no metal can afford a substitute for iron. Though the scarcity, the brilliancy, and durability of gold and silver may place them in a higher rank in these respects, yet the service which iron renders to society entitles it to a higher degree of estimation in the minds of men who are accustomed to think with justice and propriety. It is true that it does not shine with a splendor equally strong; nature has not decorated it with so beautiful a color, but its intimate properties are much more precious. All the other metals might, in truth, be dispensed with; but iron, on the contrary, is indispensable and necessary. The condition of humanity would be truly miserable without this metal, as is proved by the history of those people with whom the art of working it is still unknown, and who, with joy and exultation, exchange the gold with which their country is enriched for morsels of iron which happier and more cultivated nations bring to them in exchange. Iron composes the first instrument of machines, and the first mover of mechanics. In the hands of men it governs, and, as it were, subdues all the products of nature. In successive obedience to his power, we behold it change the form and properties of other bodies, by the perpetual influence it exercises upon them. In a word, it is the soul of all the arts, and the source of almost every beneficial product.

Though a thousand facts in history prove that the ancients were not acquainted with the art of working iron like the modern nations, the historians of Chemistry have nevertheless placed the infancy of their science among the first operators at the forge, whose existence they have admitted almost in the first ages of the world.

The alchemists qualified iron with the name of Mars, by consecrating it to the god of war, in whose service it has been much

employed. From the denomination of Mars being given to iron, naturally flowed the appellation *martial*, which has been successively attributed to numerous preparations made with this metal.

Iron possesses a peculiar metallic brilliancy. When we wish to describe its color, we are obliged to say that it is white, rather livid, inclined to grey and to blue. In its texture it is formed of small fibrous threads, or small grains, and small plates very pointed. When examined with the microscope, it presents a great number of pores, or small cavities, more perceptible than in copper. It appears that its interior texture, as shown in its fracture, which is more or less fibrous, granulated, or lamellated, depends much on the method of its cooling, the pressure it has undergone, the manner of treatment, and the heat under which it has been forged or struck.

The specific gravity of iron varies from 7·600 to 7·800. Its hardness exceeds that of any other metal, and on this account it is used to grind, cut, fashion, engrave, and file most natural bodies, stones, wood, and particularly the other metals. It is also the most elastic of metals, and is therefore preferred to all the others for springs of every description.

The ductility of iron is also very considerable; but it is in some sort of a particular kind, or rather it is limited by its excessive hardness, or the cohesion of its particles. Though these adhere much more strongly than most of the other metallic substances, it cannot be made into plates as thin as are formed of several other of the latter; the thinnest sheet iron is in fact much thicker than very coarse leaves of lead or tin. For this reason iron is commonly placed in the fourth rank among metals as to its ductility, and this place is given on account of its ductility in the wire-drawer's plates. Its malleability is very limited on account of its firmness, so that its ductility is much more eminent and remarkable. A wire of this metal of one tenth of an inch in diameter supports a weight of four hundred and fifty pounds before it breaks, which cannot be done with any other metal, not even copper and platina, which approach the nearest to it. Muschenbroeck, by examining a parallelopipedon of iron, of one tenth of an inch in diameter, was obliged to use a force of seven hundred and forty pounds to break it; and he remarks on this occasion, that a similar piece of iron, forged of horse-shoe nails, which had remained for some time in the hoof of a horse, did not exhibit a greater tenacity. This opinion is, therefore, a prejudice which arises only from the goodness and purity of iron made use of for forging those nails. When heated to about 158° of Wedgewood's pyrometer, as Sir George M'Kenzie has ascertained, it melts. This temperature being nearly the highest to which it can be raised, it has been impossible to ascertain the point at which this melted metal begins to boil and evaporate. Neither has the form of its crystals been examined: but it is well known that the texture of iron is fibrous; that is, it appears when broken to be composed of a number of fibres or strings bundled together.

Iron is rapidly penetrated by the electric fluid. It is one of the best conductors of electricity; and, accordingly, since the discoveries of Franklin on the identity of atmospheric thunder and electric spark, it is employed with great success to fabricate those elevated conductors, which are appropriated by their gilded and unalterable terminations in a point, to attract without noise, and rapidly to transport, the electric matter into the earth, or into water, where their inferior extremities terminate. It has been long observed that iron thus vertically placed in an elevated situation of the atmosphere, if it remains a long time, or be struck with the electric fluid of lightning, assumes the properties of a magnet. If iron be struck in the air by the electric shock, it takes fire; but as this phenomenon belongs to the history of its combustion, we shall speak of it in another place.

Magnetism is one of the most characteristic, and at the same time most singular of the properties of iron. It was long supposed to be peculiar to this metal, but it is now well known that cobalt and nickel also possess it. Nevertheless, all the experiments relative to the magnetism of these two last metals not having been made either with the same accuracy, or to the same extent, as upon iron, the principal phenomena of this force have been well observed only in the latter metal.

The taste and smell are also two very distinct and very evident properties in iron. If we hold a piece of iron for some time in the hand, and afterwards hold it a little distance from the nose, we may discern its odor and quality.

When exposed to the air its surface is soon tarnished, and it is gradually changed into a brown or yellow powder, well known under the name of rust. This change takes place more rapidly if the atmosphere be moist. It is occasioned by the gradual combination of the iron with the oxygen of the atmosphere, for which it has a very strong affinity.

Carburet of iron is found native, and has been long known under the names of plum-

bago and *black lead.* It is of a dark iron grey or blue color, and has something of a metallic lustre. It has a greasy feel, is soft, and blackens the fingers, or any other substance to which it is applied. It is found in many parts of the world, especially in Britain,* where it is manufactured into pencils. It is not affected by the most violent heat, as long as air is excluded, nor is it in the least altered by simple exposure to the air or to water. A moderate heat produces no effect upon it, and occasions but little change in its bulk. It is used, therefore, in making the crucibles called *black lead.* It was long supposed to be incombustible.

* The chief mines are at Keswick in Cumberland, and in Airshire.

Animal Mechanics, or Proofs of Design in the Animal Frame. [From the Library of Useful Knowledge.]

(Continued from page 177.)

There is another curious circumstance in the form of the thigh bone, showing how it is calculated for strength as well as freedom of motion. To understand it we must first look to the *dishing* of a wheel. The dishing is the oblique position of the spokes from the nave to the felly, giving the wheel a slightly conical form. When a cart is in the middle of a road, the load bears equally upon both wheels, and both wheels stand with their spokes oblique to the line of gravitation.

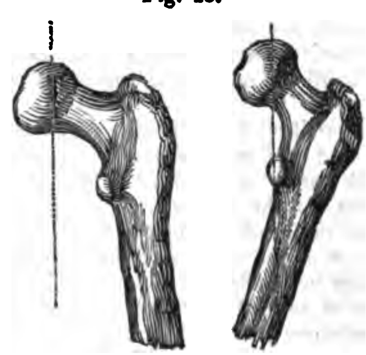
If the cart is moving on the side of a barrel shaped road, or if one wheel falls into a

Fig. 17.

rut, the whole weight comes upon one wheel; but the spokes of that wheel, which were oblique to the load, when it supported only one-half of the weight, are now perpendicular under the pressure, and are capable of sustaining the whole. If roads were made perfectly level, and had no holes in them, the wheels of carts might be made without dishing; but if a cart is calculated for a country road, let the wheelwright consider what equivalent he has to give for that very pretty result proceeding from the obliquity of the spokes, or *dishing* of the wheel.

When we return to consider the human thigh bone, we see that the same principle holds; that is to say, that whilst a man stands on both his legs, the necks of the thigh bones are oblique to the line of gravitation of the body; but when one foot is raised, the whole body then being balanced on one foot, a change takes place in the position of the thigh bone, and the obliquity of that bone is diminished; or, in other words, now that it has the whole weight to sustain, it is perpendicular under it, and has therefore acquired greater strength.

Fig. 18.



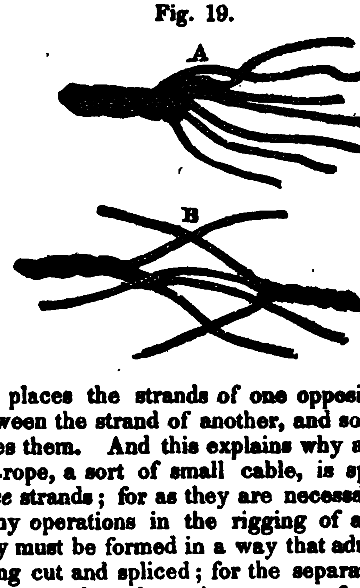
CHAPTER V.

Of the Tendons compared with Cordage.—Where nature has provided a perfect system of columns, and levers, and pullies, we may anticipate that the cords by which the force of the muscles is concentrated on the moveable bones, must be constructed with as curious a provision for their offices. In this surmise we shall not be disappointed. To understand what is necessary to the strength of a rope or cable, we must learn what has been the object of the improvements and patents in this manufacture. The first process in rope making is hatchelling the hemp; that is, combing out the short fibres, and placing the long ones parallel to one another. The second is spinning the hemp into yarns. And here the principle must be attended to, which goes through the whole process in forming a cable; which is that the fibres of the hemp shall bear an equal strain; and the difficulty may be easi-

ly conceived, since the twisting must derange the parallel position of the fibres. Each fibre, as it is twisted, ties the other fibres together, so as to form a continued line, and it bears at the same time a certain portion of the strain, and so each fibre alternately. The third step of the process is making the yarns. Warping the yarns is stretching them to a certain length; and, for the same reason that so much attention has been paid to the arrangement of the fibres for the yarns, the same care is taken in the management of the yarns for the strands. The fourth step of the process is to form the strands into ropes. The difficulty of the art has been to make them bear alike, especially in great cables, and this has been the object of patent machinery. The *hardening* by twisting is also an essential part of the process of rope-making; for without this it would be little better then extended parallel fibres of hemp. In this twisting, first of the yarns and then of the strands, those which are on the outer surface must be more stretched than those near the centre; consequently, when there is a strain upon the rope the outer fibres will break first, and the others in succession. It is to avoid this that each yarn and each strand, as it is twisted or hardened, shall be itself revolving, so that when drawn into the cable the whole component parts may, as nearly as possible, resist the strain in an equal degree; but the process is not perfect, and this we must conclude from observing how different the construction of a tendon is from that of a rope. A tendon consists of a strong cord apparently fibrous, but which, by the art of the anatomist, may be separated into lesser cords, and these by maceration, can be shown to consist of cellular membrane, the common tissue that gives firmness to all the textures of the animal body. The peculiarity here results merely from its remarkable condensation. But the cords of which the larger tendon consists do not lie parallel to each other, nor are they simply twisted like the strands of a rope; they are, on the contrary, plaited or interwoven together.

If the strong tendon of the heel, or Achilles tendon, be taken as an example, on first inspection it appears to consist of parallel fibres, but by maceration these fibres are found to be a web of twisted cellular texture. If you take your handkerchief, and, slightly twisting it, draw it out like a rope, it will seem to consist of parallel cords; such is, in fact, so far the structure of a tendon. But, as we have stated, there is something more admirable than this, for the tendon consists of subdivisions, which are like the strands of a rope; but instead of being twisted simply as by the process of hardening, they are plaited or interwoven in a way that could not be imitated in cordage by the turning of a wheel. Here then is the difference: by the twisting of a rope the strands cannot resist the strain equally, whilst we see that this is provided for in the tendon by the regular interweaving of the yarn, if we may so express it, so that every fibre deviates from the parallel line in the same degree, and consequently receives the same strain when the tendon is pulled. If we seek for examples illustrative of this structure of the tendons, we must turn to the subject of ship rigging, and see there how the seaman contrives, by undoing the strands and yarns of a rope, and twisting them anew, to make his splicing stronger than the original cordage. A sailor opens the ends of two ropes thus:*

Fig. 19.



and places the strands of one opposite and between the strand of another, and so interlaces them. And this explains why a hawser-rope, a sort of small cable, is spun of *three* strands; for as they are necessary for many operations in the rigging of a ship, they must be formed in a way that admits of being cut and spliced; for the separation of three strands, at least, is necessary for knotting, splicing, whipping, mailing, &c. which are a few of the many curious contrivances for joining the ends of ropes, and for strengthening them by filling up the interstices to preserve them from being cut or frayed. As these methods of splicing and plaiting in the subdivisions of the rope make an intertexture stronger than the original rope, it is an additional demonstration, if any were wanted, to show the perfection of the cordage of an animal machine, since the tendons are so interwoven; and until the yarns of

* A. strands and yarns opened. B, ends opened and laid for splicing, in a manner exactly like the interlacing of the tendon.

one strand be separated and interwoven with the yarns of another strand, and this done with regular exchange, the most approved patent ropes must be inferior to the corresponding part of the animal machinery.

A piece of cord of a new patent has been shown to us, which is said to be many times stronger than any other cord of the same diameter. It is so far upon the principle here stated, that the strands are plaited instead of being twisted; but the tendon has still its superiority, for the lesser yarns of each strand in it are interwoven with those of other strands. It however gratifies us to see, that the principle we draw from the animal body is here confirmed. It may be asked, do not the tendons of the human body sometimes break? They do; but in circumstances which only add to the interest of the subject. By the exercise of the tendons, (and their exercise is the act of being pulled upon by the muscles, or having a strain made on them,) they become firmer and stronger; but in the failure of muscular activity, they become less capable of resisting the tug made upon them, and if, after a long confinement, a man has some powerful excitement to muscular exertion, then the tendon breaks. An old gentleman, whose habits have been long staid and sedentary, and who is very guarded in his walk, is upon an annual festival tempted to join the young people in a dance; then he breaks his tendo Achillis. Or a sick person, long confined to bed, is, on rising, subject to a rupture or hernia, because the tendinous expansions guarding against protrusion of the internal parts, have become weak from disease.

Such circumstances remind us that we are speaking of a living body, and that, in estimating the properties of the machinery, we ought not to forget the influence of life, and that the natural exercise of the parts, whether they be active or passive, is the stimulus to the circulation through them, and to their growth and perfection.

CHAPTER VI.

OF THE MUSCLES—OF MUSCULARITY AND ELASTICITY.—There are two powers of contraction in the animal frame—elasticity, which is common to living and dead matter, and the muscular power, which is a property of the living fibre.

The muscles are the only organs which properly have the power of contraction, for elasticity is never exerted but in consequence of some other power bending or stretching the elastic body. In the muscles, on the contrary, motion originates; there being no connection, on mechanical principles, betwixt the exciting cause and the power brought into action.

The real power is in the muscles, while the safeguard against the excess of that power is in the elasticity of the parts. This is obvious in the limbs and general texture of the frame; but it is most perfectly exhibited in the organs of circulation. If the action of the heart impelled the blood against parts of solid texture, they would quickly yield. When by accident this does take place, even the solid bone is very soon destroyed, but the coats of the artery which receive the rush of blood from the heart, although thin, are limber and elastic; and by this elasticity or yielding, they take off or subdue the shock of the heart's action, while no force is lost: for as the elastic artery has yielded to the sudden impulse of the heart, it contracts by elasticity in the interval of the heart's pulsation, and the blood continues to be propelled onward in the course of the circulation, without interval, though regularly accelerated by the pulse of the heart.

If a steam engine were used to force water along the water-pipes, without the intervention of some elastic body, the water would not flow continuously, but in jerks, and therefore a reservoir is constructed containing air, into which the water is forced against the elasticity of the air. Thus, each stroke of the piston is not perceptibly communicated to the conduit pipe, because the intervals are supplied by the push of the compressed air. The office of the reservoir containing air is performed in the animal body by the elasticity of the coats of the arteries, by which means the blood which flows interruptedly into the arteries has a continuous and uninterrupted flow in the veins beyond them.

A muscle is fibrous, that is, it consists of minute threads bundled together, the extremities of which are connected with the tendons which have been described. Innumerable fibres are thus joined together to form one muscle, and every muscle is a distinct organ. Of these distinct muscles for the motions of the body there are not less than four hundred and thirty-six in the human frame, independent of those which perform the internal vital motions. The contractile power which is in the living muscular fibre, presents appearances which, though familiar, are really the most surprising of all the properties of life. Many attempts have been made to explain this property, sometimes by chemical experiment, sometimes on mechanical principles, but always in a manner repugnant to common sense. We must be satisfied with saying that it is an endowment,

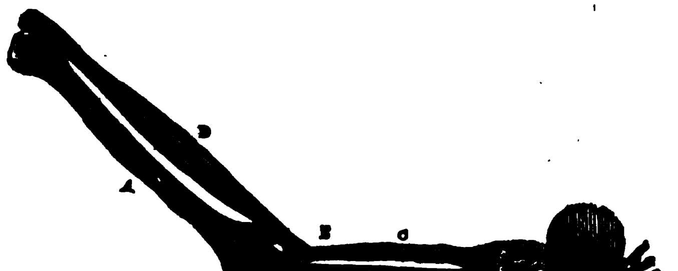
the cause of which it would be as vain to investigate as to resume the search into the cause of gravitation.

The ignorance of the cause of muscular contraction does not prevent us from studying the laws which regulate it, and under this head are included subjects of the highest interest, which, however, we must leave, to pursue the mechanical arrangement of the muscles.

Since we have seen that there are four hundred and thirty-six distinct muscles in the body, it is due to our readers to explain how they are associated to effect that combination which is necessary to the motion of the limbs, and to our perfect enjoyment. In the first place, the million of fibres which constitute a single muscle are connected by a tissue of nerves, which produce a unison or sympathy amongst them, so that one impulse causes a simultaneous effort of all the fibres attached to the same tendon. When we have understood that the muscles are distinct organs of motion, we perceive that they must be classed and associated, in order that many shall combine in one act; and that others, their opponents, shall be put in a state to relax and offer no opposition to those which are active. These relations can only be established through *nerves*, which are the organs of communication with the brain, or sensorium. The nerves convey the will to the muscles, and at the same time they class and arrange them to as to make them consent to the motions of the body and limbs.

On first looking to the manner in which the muscles are fixed into the bones, and the course of their tendons, we observe everywhere the appearance of a sacrifice of mechanical power, the tendon being inserted into the bone in such a manner as to lose the advantage of the lever. This appears to be an imperfection, until we learn that there is an accumulation of vital power in the muscle in order to attain velocity of movement in the member.

Fig. 20

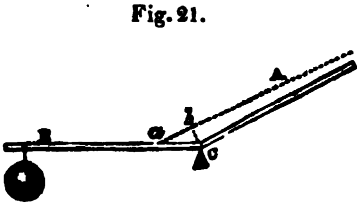


The muscle, D, which bends the fore-arm, is inserted into the radius, E, so near the fulcrum, or centre of motion, in the elbow joint, and so oblique, that it must raise the hand and fore-arm with disadvantage. But, correctly speaking, the power of the muscle is not sacrificed, since it gains more than an equivalent in the rapid and lively motions of the hand and fingers, and since these rapid motions are necessary to us in a thousand familiar actions; and to attain this the Creator has given sufficient vital power to the muscles to admit of the sacrifice of the mechanical or lever power, and so to provide for every degree and variety of motion which may answer to the capacities of the mind.

If we represent the bones and muscles of the fore-arm by this diagram, we shall see that power is lost by the inclination of the tendon to the lever into which it is inserted. It represents the lever of the third kind, where the moving power operates on a point nearer the fulcrum than the weight to be moved.

Here A represents the muscle, B the lever, and C the fulcrum. The power of the muscle is not represented by the distance ot its insertion, *a*, from the fulcrum C. The

Fig. 21.



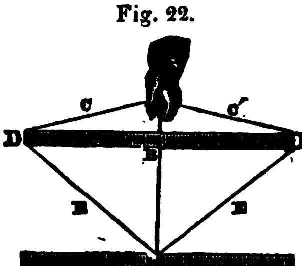
line which truly represents the lever must pass from the centre of motion perpendicularly to the line of the tendon, namely C *b*. Here again, by the direction of the tendon, as well as by its actual attachment to the bone, power is lost and velocity gained.

We may compare the muscular power to the weight which impels a machine. In studying machinery it is manifest that weight and velocity are equivalent. The handle of the winch in a crane is a lever, and the space through which it moves, in comparison with the slow motion of the weight, is the measure of its power. If the weight raised by the crank be permitted to go down, the wheels revolve, and the handle moves with the velocity of a cannon ball, and will be as destructive if it hit the workman. The weight here is the power, but it operates with so much disadvantage that the hand upon the handle of the winch can stop it: but give it way, let the accelerated motion take place, and the hand would be shattered which touched it. Just so the fly wheel, moving at first slowly, and an impediment to the working of a machine, at length acquires momentum so as to concentrate the power of the machine, and enable it to cut bars of iron with a stroke.

The principle holds in the animal machinery. The elbow is bent with a certain loss of mechanical power; but by that very means, when the loss is supplied by the living muscular powers, the hand descends through a greater space, moves quicker, with a velocity which enables us to strike or to cut. Without this acquired velocity, we could not drive a nail; the mere muscular power would be insufficient for many actions quite necessary to our existence.

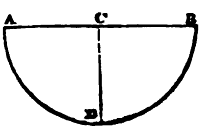
Let us take some examples to show what objects are attained through the oblique direction of the fibres of the muscles, and we shall see that here, as well as by the mode of attachment of the entire muscle, velocity is attained by the sacrifice of power. Suppose that these two pieces of wood, to be

Fig. 22.



drawn together by means of a cord, but that the hand which pulls, although possessing abundant strength, wants room to recede more than what is equal to one-third of the space betwixt the pieces of wood, it is quite clear that if the hand were to draw direct on the cord, A B, the point A would be brought towards B, through one-third only of the intervening space, and the end would not be accomplished. But if the cord were put over the ends of the upper piece, C, D, E, and consequently directed obliquely to their attachment at A, on drawing the hand back a very little, but with more force, the lower piece of wood would be suddenly drawn up to the higher piece, and the object attained. Or we may put it in this form: If a muscle be in the direction of its tendon, the motion of the extremity of the tendon will be the same with that of the muscle itself: but if the attachment of the muscle to the tendon be oblique, it will draw the tendon through a greater space; and if the direction of the muscle deviate so far from the line of the tendon as to be perpendicular to it, it will then be in a condition to draw the tendon through the greatest space with the least contraction of its own length

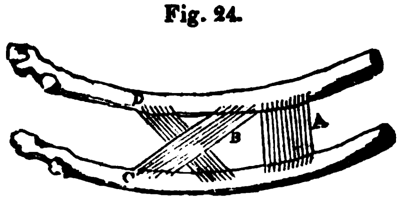
Fig. 23.



Thus, if A B be a tendon, and C D a muscle, by the contraction of C to D the extremities of the tendon A B will be brought together through a space double the contraction of the muscle. It is the adjustment on the same principle which gives the arrow so quick an impulse from the spring of the bow, the extremities of the bow drawing obliquely on the string.

To free breathing, it is necessary that the ribs shall approach each other, and this is performed by certain *intercostal* muscles, (or muscles playing between the ribs,) and now we can answer the question, why are the fibres of these muscles oblique?

Fig. 24.

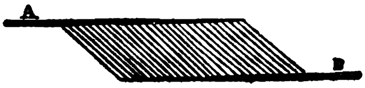


Let us suppose this figure to represent two ribs with thin intervening muscles. If the fibres of the muscle were in the direction A, across, and perpendicular to the ribs; and if they were to contract one third of their length, they would not close the intervening space; they would not accomplish the purpose. But being oblique, as at B,

although they contract no more than one-third of their length, they will bring the ribs C D together. By this obliquity of the intercostal muscles they are enabled to expand the chest, in inspiration, in a manner which could not be otherwise accomplished.

In the greater number of muscles the same principle directs the arrangement of the fibres; they exchange power for velocity of movement, by their obliquity. They do not go direct from origin to insertion, but obliquely, thus, from tendon to tendon:

Fig. 25.



Supposing the point A to be the fixed point, these fibres draw the point B with less force, but through a larger space, or more quickly than if they took their course in direct lines; and by this arrangement of the fibres the freedom and extent of motion in our limbs are secured.

But the muscles must be strengthened by additional courses of fibres, because they are oblique; since by their obliquity they lose something of their force, and therefore it is, we must presume that we find them in a double row, making what is termed the *penniform* muscle, thus—

Fig. 26.

and sometimes the texture of the muscle is still further compounded by the intermixture of tendons, which permit additional series of fibres; and all this for the obvious purpose of accumulating power, which may be exchanged for velocity of movement.

Plan of an Apiary or Bee-house, by means of which the honey and wax can be taken without destroying the Bees. By G. [From the Quarterly Journal of Agriculture, &c.]

First,—Erect a building of wood, of dimensions according to the extent you may wish to avail yourself of the labor of bees. A frame building of 7 feet square, and 7 feet high to the eaves, will contain 90 hives of the dimensions after mentioned. The front should face the south or south-east. The sides of the house within should be shelved with stout plank, well supported by uprights and cross pieces, to hold the hives. The lower shelf may be about a foot from the floor, and the others about 14 inches apart. A tier of shelves is to be placed in the middle of the house, at the same distances from each other; this arrangement will leave two feet gangway between the shelves for the convenience of passing between the hives. There must of course be a door to each gangway, if the shelves are continued from the front to the rear of the house.

Secondly,—The hives must be made as near as may be of 12 inches square, and 12 inches high outside; it being found that a hive of these dimensions, well filled, is sufficient to support an ordinary swarm of bees through the winter. The hives should have a bottom board to fit close, but it need not be nailed fast; each hive must have two openings at bottom, exactly opposite each other, 3 inches wide, and ½ inch high; these openings are furnished with shutters of tin or thin wood, moveable in a groove, in order to close them when the hives are to be removed. On the opposite side of each hive should be inserted a pane of glass, covered with a shutter, to enable you to see, on raising the shutter, that the hives are full. For the greater convenience of opening and shutting the apertures into the hives, they should be made of a slit of tin long enough to reach from the aperture, when closed, to the outside of the hive. In the front of the house there must be openings to correspond with the front hives within, and on the outside there should be placed a small shelf to each aperture for the bees to alight on.

You may begin to stock your house in the winter with old hives, placing a new hive of the above dimensions in front of the old one, and in the spring the bees, after filling up the old comb, will fall to work in the new hive. As soon as you perceive this, you may drive the bees from the old hive by striking on it, or by injecting the smoke of tobacco, and take it away; or take it away and set it down in front of the house, invert it and take off the bottom board—before night, the bees will have all left it and gone into the new hive. When the new hive is filled, close the apertures, draw it back and place another in front; open the communication, and they will in like manner fill this hive. You thus continue to supply hives till your shelves are full. In the fall you may take up as many as you find there are no bees in, leaving however sufficient honey to support the stock through the winter.

In order to derive the greatest possible advantage from their bees, some people take away in the spring all the old comb and

honey that the bees have left unconsumed. But this should not be done until you are well assured that the bees can get their living from the early spring flowers. This can only be done, however, but by those persons the bees will not sting, or by protecting the hands and face from their attacks.

G.

Internal Improvements, No. IV. By F. To the Editor of the American Railroad Journal and Advocate of Internal Improvements.

Sir,—Before taking leave of the subject of turnpike roads, we must intreat your further indulgence for a few moments, to make a brief reply and offer a few remarks in relation to an objection that has been frequently advanced against the indiscriminate adoption of M'Adam's system of construction. It may be true, as has been stated, that there are spots highly favored in themselves as to natural advantages,—rich in every mineral and agricultural resource—but at the same time so sequestered and shut out beyond the pale of intercourse with more populous parts of the country, as to render them unavailable, except to a very limited extent. Capitalists, however, cannot be induced to embark in projects that offer but little promise of profit, and that little uncertain and remote. They require something more tangible, and will not seek in distant quarters for that which they may have without seeking at home; and it therefore stands to reason, that so long as safer and more advantageous investments are to be met with here by greater facilities, such places, however strong their claim to notice may be, must of necessity remain in a state of crude, uncultivated nature, or be content with such modifications of approved plans as may be in some degree commensurate with their available means.

We are no friends to the forcing system, and would at any time use our best efforts to discourage any project having a tendency to that end; but, we still think that some substitute might be safely recommended to meet such cases as those alluded to above, without in any manner compromising the great end of Internal Improvements, which is to bring out to the best advantage the resources of a country by any means that the nature and extent of those resources will justify. If a substitute be adopted, it should combine in its qualifications a hard and even surface, with great cheapness of construction. These are qualities indispensably necessary to the furtherance of the end in view—and as they seem to be embodied in a plan recently proposed by an engineer of some eminence in Ohio, we shall content ourselves in referring to a former number of this journal for a full explanation of its principles, by observing that much depends upon the quality and seasoning of the timber used in the formation of the ways. Evaporation principally takes place in the direction of the fibres of the wood; and the juxtaposition of the parts where green timber is used must therefore prevent the whole escape of the natural juices. Decay, under these circumstances, is soon engendered, and the durability of the road thereby materially affected. The originality and real merit of the plan, however, recommend it warmly to notice; and, as applicable to the cases alluded to above, where preliminary measures are necessary to the introduction of more perfect means, it is particularly deserving of attention. For the end ever to be kept in view, in the introduction of all improvements and innovations, should be the best interest of the particular section of country through which it may pass; and to this effect such measures only should be adopted as a calm and deliberate examination of its condition, with a careful investigation of its capacity of improvement, may dictate as most conducive to the speedy development of its natural resources. It will be admitted that every district possesses certain capabilities, which are only prevented from being brought into action by its distance from some sea-port town; and that every place having a tendency to increase its facilities of intercourse therewith must exercise a corresponding influence on the improvement of its condition. It is still, however, of vital importance to the early and successful establishment of prosperity, that the infantine exertions of such district be carefully fostered and guarded against all undue encroachments—thus, an avenue being laid open, no further apprehension need be entertained. A change of condition will soon be manifested by increased activity and prosperity; and its necessities will thenceforth be promptly met by additional facilities: for, as the motive that first incites to action stimulates with greater force to perseverance, so the enjoyment of increased prosperity animates to still greater exertions for its consummation.

As civilization attains a higher degree of perfection, and commerce becomes more generally extended, the luxuries and comforts of life demand the adoption of some new mode of communication more suitable to the advanced state of the arts and manufactures. Railroads and canals thence took their rise; and all countries to which ancient history directs our attention, seem to have availed of them according as necessity has dictated or circumstances justified. Indeed, it is a remarkable fact, that the only countries which have never emerged from their primitive state of barbarism and ignorance are those which are destitute of the means of inland navigation. This is strikingly exemplified in the inland parts of Africa, and in that part of Asia lying north of the Euxine and Caspian—the ancient Scythia and the modern Tartary and Siberia. On the other hand, wherever these means have been enjoyed, there civilization has prospered, and the arts and sciences have flourished. Thus, Egypt was the birthplace of agriculture and manufactures—the banks of the Nile were the sites of its towns and villages, which, together with those of the ancient Indians and Chinese, derived their prosperous condition and immense wealth almost exclusively from their inland navigation.

The experience of past ages therefore proves

to us that every means, having for its end the promotion of internal commerce, is deserving the consideration of all civilized communities, and particularly of one like our own, in the enjoyment of every variety of soil and clime, and capable of every species of production, either of agriculture or manufactures. The system of society is so complex in its character, and its various orders so mutually interwoven by natural causes, that a good effect cannot be produced in any one part without exercising a corresponding happy influence over the other; generating thereby a mutual dependance among all classes—the high, the low—the rich, the poor—the agriculturist, the manufacturer. The interests of each converge towards the same point; and it should, therefore, be the duty of each, collectively and individually, to concentrate their energies, and unite their efforts, to the accomplishment of the same great end. Once establish a mutual interchange of the different products of industry, by facilitating the means of intercourse between distant places, and the very objects of that industry thence become more varied, and the general commerce of the country less liable to interruption from the effects of artificial causes; and the action of any particular calamity, to which every society in its social character is more or less exposed, would thence produce but a temporary and partial evil, and would find its own correction in the reaction produced by a continuation of the exciting cause.

These remarks will not, of course, apply to a country exclusively possessing agricultural industry. In such country, the influence of foreign competition on its peculiar staples exercises a direct tendency to stimulate production to an extent that is calculated to overstock and glut the market. The price of the article thence becomes insufficient to meet the expense of raising it; and the cultivator, as a consequence, unless speedily relieved by the introduction either of new staples or new markets of consumption, must sooner or later sink under the pressure, and be reduced to the lowest state of poverty. A most deplorable instance of this truth has already been experienced in some of the Southern States of this Union—where the very articles that, for many years, proved a fertile source of revenue to the cultivator, became, not long since, owing to an excessive production, so reduced in value as to be altogether inadequate to the task of maintaining him above actual want.

But, however palpable the causes by which these effects are produced may appear, it is still a prolific source of speculation among philanthropists how far the rapid extension of manufactures, through the medium of machinery and internal improvements, is advantageous to a country as regards its moral and social condition. It has been observed, and cannot be denied, that every improvement in machinery, by which manual labor is materially lessened, is calculated to produce distress with a certain class of the community, by depriving them of their usual means of employment, and obliging them thereby to recommence the world, so to speak, in the adoption of some new vocation. But, at the same time, it must be remembered that the direct tendency of the operation of any improvement of this kind is to increase the consumption of the product of its labors by lessening its nominal value. A wider field is thus at once opened to enterprise—additional resources made attainable,—and, therefore, while the evil complained of is only temporary, and confined to a limited, a very insignificant numerical portion of that community, the benefit conferred is permanent and diffused throughout the whole mass of society. Besides, what tends more to elevate the condition of the poor—to exalt and ennoble the character of man—than the encouragement of all such means as will supersede the necessity for application of mere animal force? It is the degrading tendency of his occupation which alone reduces the poor operator to the lowest grade of human depravity—hardens his conscience—and stifles in his breast every natural feeling of moral excellence. Relieve his mind from this sense of degradation, and his ambition will soon take a loftier flight. He will feel a superiority over the brute creation that will elevate him above his former sphere and urge him on to greater efforts. The faculties of mind thus awakened will be thenceforth directed to the accomplishment of those means of luxury and enjoyment that before were only attainable at unceasing toil and labor.

It is unnecessary to pursue this subject further; for it is obvious that every improvement in machinery must be attended by results highly beneficial to the community at large; and internal communications, as a step preliminary to their introduction and application, should engage a large share of attention from every well wisher to his country. Let every channel, therefore, through which information on the subject can be derived, be opened to public inspection; let its sources be examined with a view to the general good; and let its stream flow pure and unadulterated by the poison which has hitherto polluted it, and we then hazard nothing in the assertion that, under its genial influence, the arts of peace will be cherished and commercial reciprocities cultivated. F.

New-York, February 8, 1834.

Landscape Gardening.—From the Report of the Visiting Committee of the New-York Horticultural Society for 1828, we make an extract. The subject still needs the encouragement of the Society.

"With regard to landscape gardening, the Committee have to report that, from the examination which they were able to make in the vicinity of this city, they are of opinion this part of horticulture is yet in its infancy among us as an art. The art of laying out grounds, so as to display all their beauties and conceal their defects, is a subject of much interest in Europe, where large sums are expended in embellishing the grounds surrounding the dwellings of the proprietors. There the

profession of landscape gardener is common, though almost unheard of among us; a profession requiring the practical gardener's skill, with a knowledge of the qualities and nature of forest trees, their capacity for picturesque effect, either separately or in groupes, a correct taste in selecting natural or creating artificial beauties, and a practised eye in discriminating the varied features of natural scenery. With these qualifications, the landscape gardener has tracts of land of considerable extent and diversity to operate on, assisted by all the resources which the wealth and taste of the proprietor can supply. The grounds attached to the country residences of our citizens are usually too limited to give much opportunity for the display of this style of gardening, and are generally appropriated to the more useful and profitable purposes of the kitchen garden, or the orchard, a small portion near the dwelling being reserved for parterres. There are, however, many beautiful sites in the neighborhood of our city, particularly those which border on our waters, in which a fine effect might be produced, by a proper application of the principles of this branch of horticulture. For improvements in this, as well as in the preceding departments, we must depend upon the greater diffusion of wealth among us, and the consequent greater leisure and opportunities for devotion to the pleasures of such pursuits. It is the legitimate province of our society to accelerate the progress of improvement in this respect; and the committee would beg leave to recommend the subject to their attention, as worthy of the same encouragement which the Society offers to the other branches of horticultural skill. A. Halsey, Chairman.

"New-York, January 27, 1829."

Planting a Vine.—Every proprietor of a house in this city should plant one or more vines in the yard. By so doing, he will add, in four or five years, at least ten dollars to his rent. Most people would be induced to give an additional sum in the rent of a house, in the yard of which there is a fine bearing grape vine. The Isabella is so certain in its growth, and in its bearing, and so cheap too, that no landholder need be disappointed in realizing the fruit of his labor and expense.

Posts.—The Shakers at Union Village have been in the habit of making oak posts as durable as locust, by a very simple and easy process. This is merely to bore a hole in that part of the post which will be just at the surface of the earth, with such a slope as will carry it just below the surface, and fill it with salt.

Preservation of Ink.—It is well known that the common writing ink, commonly made of vinegar or water for the liquid, cause the ink to mother, dry, and of course becoming thick, and unfit for use, unless often mixed up. Having occasion lately to make use of some strong salt-brine, for a certain purpose, and placing the vessel containing the brine near my inkstand, the thought occurred to me, that it would prevent the mothering and drying up of the ink, by mixing it with the thick substance in the inkstand. Accordingly I mixed some of the brine with the inky matter, and found upon a fair trial, my anticipation realized. It keeps the inky compound entirely free and open, consequently the pen clean, which is a great desideratum with all who have use for the goosequill. Please try and satisfy yourself. J. N. B.—[N. E. Farmer.]

To prevent Beer from becoming Acetous.—There is a way to prevent beer from getting acetous, or what is called hard, which is as simple as it is efficacious. Reasoning on the plain principles of chemical science, we were led to try it, and have this summer found its truth and advantage. It is nothing more than to suspend a knob of marble by a piece of tape from the bung hole to near the bottom of the barrel, upon which, being pure carbonate of lime, the acid quality of the beer acts on its incipient formation: it consequently becomes neutralised, and thus is kept from turning hard or sour. In our experiment the marble was considerably eaten away, except where the tape encircled, and the beer remained sound and fresh to the last drop. We mention this discovery as being a point of some consequence to householders, and especially to farmers and their laborers in harvest time; for it is more likely that weak beer should become sour than strong; it is much more healthy to drink it fresh than ever so little turned off, and, in the way of economy, many barrels might be saved, which are every year thrown into the hog-tub from becoming undrinkable. It will do good, however, to every species of beer, and, we expect, to any kind of home-made or even foreign wines in cask, which have or are likely to become tart or sour.—[Oxford Journal.]

RECEIPT FOR DRESSING SALLAD.

BY THE REV SIDNEY SMITH.

Two large potatoes, pressed through kitchen sieve,
Smoothness and softness to the sallad give,
Of mordent mustard add a single spoon,
(Distrust the condiment that bites too soon;)
But deem it not, thou man of herbs, a fault,
To add a double quantity of salt,
Four times the spoon with oil of Lucca crown,
And twice with vinegar procured from town;
True flavor needs it, and your poet begs,
The pounded yellow of two well boiled eggs;
Let onions' atoms lurk within the bowl,
And, scarce suspected, animate the whole
And lastly, in the flavored compound toss
A magic spoonful of anchovy sauce.
O! great and glorious,—O! herbaceous treat,—
'Twould tempt the dying anchorite to eat;
Back to the world he'd turn his weary soul,
And plunge his fingers in the sallad bowl.

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York—in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*. John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FOR THE WEEK ENDING APRIL 19, 1834. [NUMBER 4.

"What justly envied feelings warm the breast
Of him whose ardent soul can find no rest,
But in imparting wisdom's light serene,
And scattering science o'er life's dreary scene."—ANON.

History of Astronomy—its various Systems, &c. [Continued from page 161.]

OF THE MOON.—Next to the sun, the moon is the most remarkable of all the heavenly bodies, and is particularly distinguished by the periodical changes to which figure and light are subject.

The moon is not a primary planet, but a secondary, or *satellite,* which revolves round the earth, and accompanies it in its annual revolution round the sun. The mean time of a revolution of the moon round the earth, or the time between two successive conjunctions, is 29 days 12 hours 44 minutes; but the time she takes to perform a revolution round her orbit is only 27 days 7 hours 43 minutes. The former of these periods is called the *synodical* and the latter the *periodical* revolution. The difference between these periods is occasioned by the motion of the earth in the ecliptic; for while the moon is going round the earth, the earth advances about 29° in the ecliptic, which is nearly one degree per day, and therefore the moon must advance 29° more than a complete revolution round her orbit, before she can overtake the earth, or be again in conjunction with the sun, which will require 2 days 5 hours, her daily motion being about 13 degrees.

Of all the celestial bodies the moon is the nearest to the earth, her mean distance being only 240,000 miles, which is scarcely a four-hundredth part of the sun's distance

from the earth; but her apparent size is nearly equal to that of the sun, she must therefore be a very small body compared with the sun. Her diameter is only about 2,161 miles, and therefore the earth is about 48½ times greater; but the density of the moon is said to be to that of the earth as 5 to 4, consequently the quantity of matter contained in the earth is only about 39 times that contained in the moon.

Although the moon moves over a very considerable portion of her orbit in the course of a day, yet, on account of its smallness, her hourly motion is only about 2,290 miles, which is about one-thirtieth part of the space passed over by the earth in the same time. But in all her motions the moon is subject to great irregularities, which arise from the eccentricity of her orbit, and her proximity to the earth. The eccentricity of her orbit, as determined from the latest and most accurate observations, is 12,960 miles, or nearly one-eighteenth part of her mean distance, of course she is about one-ninth part nearer the earth on some occasions than at others.

PHASES OF THE MOON.

By Thy command the moon as daylight fades,
Lights her broad circle in the deep'ning shades;
Array'd in glory, and enthroned in light,
She breaks the solemn terrors of the night;
Sweetly inconstant in her varying flame,
She changes still, another, yet the same.—[Broome.]

Although the *phases* of the moon are among the most frequently observed phenomena of the heavens, yet they are also among the most wonderful. But on account of the frequency and regularity of the changes in the appearances and situation of this beautiful object, the causes of these phenomena are perhaps less thought of by ordinary observers, than if they were less frequent. The moon being an opaque spherical body, which appears luminous only in consequence of reflecting the light of the sun, can only have that side illuminated which is at any time turned towards the sun, the other side remaining in darkness; and as that part of her can only be seen which is turned towards the earth, it is evident that we must perceive different portions of her illuminated, according to her various positions with respect to the earth and sun.

At the time of conjunction, or when the moon is between the earth and the sun, she is then invisible on the earth, because her enlightened side is then turned towards the sun, and her dark side towards the earth. In a short time after the conjunction, she appears like a fine crescent to the eastward of the sun a little after he sets. This crescent begins to fill up, and the illuminated part to increase, as she advances in her orbit; and when she has performed a fourth part of a revolution, she appears to be half illuminated, and is then said to be in her first quarter. After describing the second quadrant of her orbit, she is then opposite to the sun, and shines with a round illuminated disc, which is called full moon. Her appearance at this time is very accurately represented by the preceding figure.

After the full she begins to decrease gradually as she moves through the other half of her orbit; and when the eastern half of her only is enlightened, she is said to be in her third quarter; thence she continues to decrease until she again disappears at the conjunction, as before.* These various phases plainly demonstrate that the moon does not shine by any light of her own; for if she did, being globular, she would always present a fully illuminated disc like the sun. That the moon is an opaque body, is not only proved from her phases, but also by the occultation of stars, for her body often comes between the earth and a star, and while she is passing it, the star is hid from our view.

MOTIONS OF THE MOON.

The neighboring moon her monthly round
Still ending, still renewing, through mid-heaven,
With borrowed light her countenance triform;†
Hence fills and empties to enlighten th' earth,
And in her pale dominion checks the night.—[Milton.]

It has already been remarked that the motions of the moon are very irregular. The only equable motion she has is her revolution on her axis, which is completed in the space of a month, or the time in which she moves round the earth. This has been determined by the important and curious circumstance, that she always presents the *same face* to the earth, at least with very little variation. But as her motion in her orbit is alternately accelerated and retarded, while that on her axis is uniform, small segments on the east and west sides alternately appear and disappear. This occasions an apparent vibration of the moon backwards and forwards, which is called her *libration* in longitude.

A little more of her disc is also seen towards one pole, and sometimes towards the other, which occasions another waving, or vacillating kind of motion, called the *libration* in latitude. This shows that the axis of the moon is not exactly, though nearly, per-

* These various phases may be satisfactorily and pleasantly illustrated, by placing a lighted candle on a table to represent the sun, a smaller at some distance from it to represent the earth, and then carrying a smaller white ball round it to represent the moon revolving round the earth.

† Increasing with horns towards the east; decreasing with horns towards the west; and at the *full*.

pendicular to the plane of her orbit; for if the axis of the moon were exactly perpendicular to the plane of her orbit, or if her equator coincided with that plane, we should perceive no other libration than that in longitude.

When the place of the moon is observed every night, it is found that the orbit in which she performs her revolution round the earth is inclined to the ecliptic at an angle of 5° 9′ at a mean rate; this angle is not only subject to some variation, but the very orbit itself is changeable, and does not always preserve the same form: for though it be elliptical, or nearly so, with the earth in one of the foci, yet its eccentricity is subject to some variation, being greater when the line of the *apsides* coincides with that of the *syzygies*, and least when these lines are at right angles to each other. But the eccentricity is always very considerable, and therefore the motion of the moon is very unequal, for like all other planets it is quickest in *perigee* and slowest in *apogee*. At a mean rate, she advances in her orbit 13° 10′ per day, and comes to the meridian about 48 minutes later every day. As the moon's axis is nearly perpendicular to the plane of the ecliptic, she can scarcely have any change of seasons. But what is still more remarkable, one half of the moon has no darkness at all, while the other half has two weeks of light and darkness alternately. For the earth reflects the light of the sun to the moon, in the same manner as the moon does to the earth; therefore, at the time of conjunction, or new moon, one half of the moon will be enlightened by the sun, and the other half by the earth; and at the time of opposition, or full moon, one half of the moon will be enlightened by the sun, but the other half will be in darkness. The earth also exhibits similar phases to the moon to what she does to the earth, but in a reverse order, for when the moon is *full*, the earth is *invisible* to the moon; and when the moon is *new*, the earth will appear to be *full* to the moon, and so on. It has been already mentioned, that the moon always presents the same face to the earth: from hence it is inferred, that one half of the moon can never see the earth at all; whilst from the middle of the other half it is always seen over head, turning round almost thirty times as fast as the moon does.

From the circle which limits our view of the moon, only one half of the earth's side next her is seen, the other half being hid below the horizon of all places on that circle.

To the moon, the earth seems to be the largest body in the universe, for it appears about thirteen times greater than the moon does to the earth.

Of the Harvest Moon.—It has long been known that the moon when full, about the time of harvest, rises for several nights nearly at the time of sun setting; but the cause of this remarkable phenomenon has not been so long known. This appearance was observed by the husbandman long before it was noticed by the astronomer; and on account of its beneficial effects in affording a supply of light immediately after sun-set, at this important season of the year, it is called the *harvest moon*.

In order to conceive the reason of this phenomenon, it must be recollected that the moon is always opposite the sun when she is full, and, of course, in the opposite sign and degree of the zodiac. Now, the sun is in the signs Virgo and Libra in August and September, or the time of harvest; and therefore the moon when full, in these months, is in the signs Pisces and Aries. But that part of the ecliptic in which Pisces and Aries is situated makes a much less angle with the horizon of places that have considerable northern latitude than any other part of the ecliptic, and therefore a greater portion of it rises in any given time than an equal portion at any other part of it. Or, which is the same thing, any given portion of the ecliptic about Pisces and Aries rises in less space of time than an equal portion of it does at any other part. And as the moon's daily motion in her orbit is about 13°, this portion of it will require less time to rise about those signs than an equal portion at any other part of the ecliptic; consequently there will be less difference between the times of the moon's rising when in this part of her orbit than in any other.*

At a mean rate the moon rises 50 minutes later on any evening than she did the preceding evening; but when she is full about the beginning of September, or when she is in that part of her orbit which rises with the signs Pisces and Aries, she rises only about 16 or 17 minutes later than on the preceding evening; consequently she will seem to rise for a few evenings at the same hour.

Although this is the case every time the moon is in this part of her orbit, yet it is little attended to, except when she happens to be *full* at the time, which can only be in August or September.

In some years this phenomenon is much more perceptible than in others, even al-

* It would tend very much to make this phenomenon understood if a terrestrial globe were at hand and rectified for the latitude of London, when reading this description.

though the moon should be full on the same day, or in the same point of her orbit. This is owing to a variation in the angle which the moon's orbit makes with the horizon of the place where the phenomenon is observed. If the moon moved exactly in the ecliptic, this angle would always be the same at the same time of the year. But as the moon's orbit crosses the ecliptic and makes an angle with it of 5° 9′, the angle formed by the moon's orbit and the horizon of any place is not exactly the same as that made by the ecliptic and the horizon. Some years it is greater and others less, even at the same time of the year, for it is subject to considerable variations, owing to the retrograde motion of the moon's *nodes*.*

If the ascending node should happen to be in the first degree of Aries, it is evident that this part of the moon's orbit will rise with the least possible angle, and, of course, any given portion of it will require less time to rise than an equal portion in any other part of the orbit. The most favorable position of the nodes for producing the most beneficial harvest moons, is therefore when the descending node is in the first of Aries, and of course the descending in the first of Libra. When the nodes are in these points 13° of the moon's orbit, about the first of Aries, rises in the space of 16 minutes in the latitude of London, and consequently, when the moon is in this part of her orbit, the time of her rising will differ only 16 minutes from the time she rose on the preceding evening. When the moon is in the opposite part of her orbit, or about the signs Virgo and Libra, which make the greatest angle with the horizon at rising, 13° of her orbit will require 1 h. 15′ to rise, although it were coincident with the ecliptic; and if the nodes be in the points just mentioned, the same portion of the orbit will require 1 h. 20′ to ascend above the horizon of the same place; and so much later will the moon rise every night for several nights when in this part of her orbit. As the moon is full in these signs in the months of March and April, they may be called *vernal full moons*.

Those signs of the ecliptic which rise with the greatest angle, set with the least; and those that rise with the least set with the greatest. Therefore, the vernal full moons differ as much in their times of *rising* every night, as the autumnal or harvest moons differ in the times of their *setting*; and they *set* with as little difference of time as the autumnal ones *rise*, supposing the full moons to happen in opposite points of the moon's orbit, and the nodes to remain in the same points of the ecliptic.

In southern latitudes the harvest moons are just as regular as in the northern, because the seasons are contrary; and those parts of the moon's orbit about Virgo and Libra, where the vernal full moons happen in northern latitudes, (and the *harvest* ones in southern latitudes,) rise at as small an angle at the same degree of *south* latitude, as those about Pisces and Aries in *north* latitude, where the autumnal full moons take place.

At places near the equator this phenomenon does not happen; for every point of the ecliptic, and nearly every point of the moon's orbit, makes the same angle with the *horizon*, both at rising and setting, and therefore equal portions of it will rise and set in equal times.

As the moon's nodes make a complete circuit of the ecliptic in 18 years 225 days, it is evident that when the ascending node is in the first of Aries at any given time, the descending one must be in the same point about 9 years 112 days afterwards; consequently there will be a regular interval of about 9½ years between the *most* beneficial and *least* beneficial harvest moons.

Apparent Size of the Moon.—It has been already remarked, at page 225, that the apparent size of the moon is nearly equal to that of the sun; but the apparent size of the moon is not always the same, for she is often much nearer the earth at one time than another; hence it is evident her apparent magnitude must vary, and that it will be greatest when she is nearest the earth. (See page 225.)

But she appears larger when in the horizon than in the zenith, even on the same evening; and yet it may easily be proved, that she is a semi-diameter of the earth, or about 4000 miles farther from the spectator when she is in the horizon than when she is in the zenith, and consequently ought to appear smaller, which will be found to be really the case if accurately measured.

This apparent increase of magnitude in the *horizontal* moon must therefore be considered as an optical illusion; and may be explained upon the well known principle, that the eye in judging of distant objects is entirely guided by the previous knowledge which the mind has acquired of the intervening objects. Hence arise the enormous estimates we make of the size of distant objects at sea, of objects below us when viewed from great heights, and of objects highly

* The nodes, or points where the moon's orbit crosses the ecliptic, move backward about 19° in a year, by which means they move round the ecliptic in 18 years 225 days.

elevated when viewed from below. Now, when the moon is near the zenith, she is seen precisely in this last situation: of course there is nothing near her, or that can be seen at the same time, with which her size can be compared; but the *horizontal* moon may be compared with a number of objects whose magnitude is previously known.

That the moon appears under no greater an angle, or is not larger, in the horizon than when she is on the meridian, may be proved by the following simple experiment:

Take a large sheet of paper and roll it up in the form of a tube, of such width as just to include the whole of the moon when she rises; then tie a thread round it to keep it exactly of the same size, and when the moon comes to the meridian, where she will appear to the naked eye to be much less, look at her again through the same tube, and she will fill it as completely as she did before.

When the moon is full and in the horizon, she appears of an *oval* form, with her longest diameter parallel to the horizon. This appearance is occasioned by the refraction of the atmosphere, which is always greatest at the horizon, consequently the lower limb or edge must be more refracted than the upper edge, and therefore these two edges will appear to be brought nearer each other, or the vertical diameter will appear to be shortened; and as the horizontal diameter is very little affected by the refraction, she must appear to have somewhat of an oval shape. The sun is affected in the same manner when in the horizon.

SPOTS, MOUNTAINS, &C. IN THE MOON.

Turn'd to the sun direct, her spotted disc
Shows mountains rise, umbrageous dales descend,
And caverns deep, as optic tube describes.
[Thomson.]

When the moon is viewed through a good telescope, her surface appears to be diversified with hills and valleys; but this is most discernible when she is observed a few nights after the Change or Opposition, for when she is either *horned* or *gibbous*, the edge about the confines of the illuminated part is jagged and uneven.

Many celebrated astronomers have delineated maps of the face of the moon; but the most celebrated are those of Hevelius, Grimaldi, Riccioli, and Cassini, in which the appearance of the moon is represented in its different states, from *new to full, and from full to new.*

The plate which we have given at page 225, represents the face of the moon as viewed by the most powerful telescopes, the light or illuminated parts being elevated tracts, some of which rise into very high mountains, while the dark parts appear to be perfectly smooth and level. This apparent smoothness in the faint parts naturally led astronomers to conclude that they were immense collections of water, and the names given to them by some celebrated astronomers are founded on this supposition. For Hevelius distinguished them by giving them the names of the seas on the earth; while he distinguished the bright parts by the names of the countries and islands on the earth. But Riccioli and Langreni distinguished both the dark and light spots by giving them the names of celebrated astronomers and mathematicians, which is now the general manner of distinguishing them.

That the spots which are taken for mountains and valleys are really such is evident from their *shadows*. For in all situations in which the moon is seen from the earth, the elevated parts are constantly found to cast a triangular shadow in a direction from the sun; and on the contrary, the cavities are always dark on the side next the sun, and illuminated on the opposite side, which is quite conformable to what we observe of hills and valleys on the earth. As the tops of these mountains are considerably elevated above the other parts of the surface, they are often illuminated when they are at a considerable distance from the line which separates the enlightened from the unenlightened part of the disc, and by this means afford us a method of even determining their height.

Previous to the time of Dr. Herschel, some of the lunar mountains were considered to be double the height of any on the earth; but by the observations of that celebrated astronomer, their height is considerably reduced.

For after measuring many of the most conspicuous prominences, he says, "From these observations I believe it is evident, that the height of the lunar mountains is in general overrated; and that when we have excepted a few, the generality do not exceed half a mile in their perpendicular elevation."

As the moon's surface is diversified by mountains and valleys as well as the earth, some modern astronomers say they have discovered a still greater similarity; namely, that some of these are really volcanoes, emitting fire, as those on the earth do. An appearance of this kind was discovered by Don Ulloa, in an eclipse of the sun, which happened on the 24th of June, 1778. It was a small bright spot, like a star near the margin of the moon, which he supposed at that time to be a hole, or valley, which permitted the sun's light to shine through it. Succeeding observations have, however, led

astronomers to believe that appearances of this kind are occasioned by the eruption of volcanic fire. Dr. Herschel, in particular, has observed several eruptions of this kind, the last of which he has described in the Philosophical Transactions for 1787, as follows: "On April the 19th, at 10 h. 6 m., I perceived three volcanoes in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwise in a state of going to break out, which perhaps may be decided next lunation. The third shows an actual eruption of fire or luminous matter. Its light is much brighter than the nucleus of the comet which M. Mechain discovered at Paris on the 10th of this month." The following night the Doctor found it burned with greater violence; and by measurement he found that the shining or burning matter must be more than three miles in diameter, of an irregular round figure, and very sharply defined about the edges. The other two volcanoes resembled large faint nebulæ, which appeared to be gradually brighter towards the middle, but no well defined luminous spot could be discovered in them. Dr. Herschel adds, "the appearance of what I have called the actual fire or eruption of a volcano exactly resembles a small piece of burning charcoal when it is covered by a very thin coat of white ashes, which frequently adhere to it when it has been some time ignited; and it had a degree of brightness about as strong as that with which a coal would be seen to glow in fair day-light."

The appearance which Dr. Herschel here describes so minutely was also observed at the Royal Observatory of Paris about six days before, by Dominic Nouet, like a star of the sixth magnitude, the brightness of which occasionally increased by flashes. Other astronomers also saw the same thing, for M. De Villeneuve observed it on the 22d of May, 1787. This volcano is situated in the north-east part of the moon, about 3′ from her edge, towards the spot called Helicon. After considering all the circumstances respecting these appearances which have just been mentioned, we must subscribe to Dr. Herschel's opinion, that volcanoes exist in the moon as well as the earth.

It has long been a disputed point among astronomers, whether or not the moon is surrounded by an atmosphere. Those who deny that she is, say that the moon always appears with the same brightness when our atmosphere is clear; which could not be the case if she were surrounded by an atmosphere like ours, so variable in density, and so often obscured by clouds and vapors.

A second argument is, that when the moon approaches a star, before she passes between it and the earth, the star neither alters its color nor its situations, which would be the case if the moon had an atmosphere, on account of the refraction, which would both alter the color of the star, and also make it appear to change its place.

A third argument is, that as there are no seas or lakes in the moon, there is, therefore, no atmosphere, as there is no water to be raised up into vapor. But those who contend that the moon is surrounded by an atmosphere, deny that she always appears of the same brightness, even when our atmosphere appears equally clear. Instances of the contrary are mentioned by Hevelius and some other astronomers, but it is unnecessary to take any further notice of them here. In the case of total eclipses of the moon, it is well known that she exhibits very different appearances, which it is supposed are owing to changes in the state of her atmosphere. It is remarked by Dr. Long, that Newton has shown that the weight of any body on the moon is but a third part of the weight of what the same body would be on the earth, from which he concludes that the atmosphere of the moon is only one third part as dense as that of the earth, and therefore it is impossible to produce any sensible refraction on the light of a fixed star which may pass through it. Other astronomers assert that they have observed such a refraction; and that Jupiter, Saturn, and the fixed stars, had their circular figures changed into an elliptical one, on these occasions. But although the moon be surrounded by an atmosphere of the same nature as that which surrounds the earth, and to extend as far from her surface, yet no such effect as a gradual diminution of the light of a fixed star could be occasioned by it, at least none that could be observed by a spectator on the earth. For at the height of 44 miles our atmosphere is so rare, that it is incapable of refracting the rays of light: now this height is only the 180th part of the earth's diameter; but as clouds are never observed higher than 4 miles, it therefore follows that the obscure part of our atmosphere is about the 2000th part of the earth's diameter, and if the moon's apparent diameter be divided by this number, it will give the angle under which the obscure part of her atmosphere will be seen from the earth, which is not quite one second, a space passed over by the moon in less than two seconds of time. It can, therefore, scarcely be expected that any obscuration of a star could be observed in so short a time, although it do take place.

As to the argument against a lunar atmosphere, drawn from the conclusion that there are no seas or lakes in the moon, it proves nothing, because it is not positively known whether there is any *water* in the moon or not.

The question of a lunar atmosphere seems to be at last settled by the numerous and accurate observations of the celebrated astronomers Shroeter and Piazzi, who have proved as convincingly as the nature of the subject seems to allow, that the moon has really an atmosphere, though much less dense than ours, and scarcely exceeding in height some of the lunar mountains.

It is remarked by Dr. Brewster, "The mountain scenery of the moon bears a stronger resemblance to the lowering sublimity, and terrific ruggedness of the Alpine regions, than to the tamer inequalities of less elevated countries. Huge masses of rock rise at once from the plains, and raise their peaked summits to an immense height in the air, while projecting crags spring from their rugged flanks, and threatening the valleys below seem to bid defiance to the laws of gravitation. Around the base of these frightful eminences, are strewed numerous, loose, and unconnected fragments, which time seems to have detached from their parent mass, and when we examine the rents and ravines which accompany the overhanging cliffs, we expect every moment that they are to be torn from their base, and that the process of destructive separation which we had only contemplated in its effects, is about to be exhibited before us in tremendous reality. The mountains called the Appenines, which traverse a portion of the moon's disc from north-east to south-west, rise with a precipitous and craggy front from the level of the *Mare* Imbrum. In some places their perpendicular elevation is above four miles; and though they often descend to a much lower level, they present an inaccessible barrier to the north-east, while on the south-west they sink in gentle declivity to the plains."

The caverns which are observed on the moon's surface are no less remarkable than the rocks and mountains, some of them being three or four miles deep, and forty in diameter. A high angular ridge of rocks, marked with lofty peaks and little cavities, generally encircles them, an insulated mountain frequently rises in their centre, and sometimes they contain smaller cavities of the same nature with themselves. These hollows are most numerous in the south-west part of the moon, and it is from this cause that this part of the moon is more brilliant than any other part of her disc. The mountainous ridges which encircle the cavities reflect the greatest quantity of light; and from their lying in every possible direction, they appear, near the time of full moon, like a number of brilliant radiations issuing from the small spot called Tycho.

It is difficult to explain with any degree of probability the formation of these immense cavities; it is highly probable that the earth would assume the same figure if all the seas and lakes were removed; and that the lunar cavities are either intended for the reception of water, or that they are the beds of lakes and seas, which have formerly existed in the moon.

The circumstance of there being no water in the moon affords a strong proof of the truth of this theory.

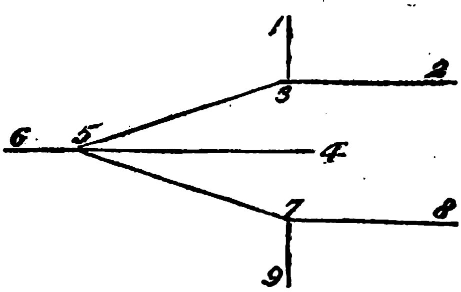
On the Currents of the Ocean. By G. K. O.

To the Editor of the Mechanics' Magazine, and Register of Inventions and Improvements.

Sir,—I have lately read the dissertation on the Oceanic Currents, in your last Number, and am induced to think the author in error as to their cause. If, according to his hypothesis, the earth received a *sudden* impulse, causing it to revolve, (I suppose of course at the same rate it now does,) and leave the waters nearly stationary, they would have appeared to a spectator at the equator to move with the velocity of 1000 miles an hour. This would continually decrease, and at length become imperceptible, on account of friction against the bottom and adjacent particles. But the time that has elapsed since the earth received its first impulse has not been sufficient to produce this effect, or so far as we are acquainted with the subject, even a similar one. Undoubtedly the cause as well as the consequence is permanent and continued, and is, I conceive, easily assigned.

The torrid zone receives more heat from the sun than any like extent of the earth's surface; consequently, its air is heated more than any other—is of less specific gravity than the cooler air of the temperate zones, and of course rises to the higher parts of the atmosphere, being forced up by the air that comes in to supply its place. This would produce a direct motion from north to south towards the equator in the directions 1–3 and 9–7.

Now, the surface of the earth, at the latitude of 45 degrees, revolves about the rate of 700 miles an hour, and if the air of that region were suddenly transferred to the equator, it would apparently move from east to west at the rate of 300 miles an hour in the direction



4–5, but as the transfer is gradual, it would receive velocity from the earth in its passage over it, and therefore its apparent velocity at the equator would be comparatively small if contrasted with the difference of velocities at 45 and 0 degrees.

We have now the two motions 3–2 and 1–2, which, being compounded, will produce the single motion 3–5. Two streams of air from the north-east and south-east, represented by 3–5 and 7–5 meet at the point 5; their opposite forces, 1–3 and 9–7, being equal, will be destroyed, and the remaining forces 2–3 and 8–7 will continue in the direction 5–6.

This, then, is the reason why, near the equator, the wind blows from east to west, and north and south of it from north-east and south-east. The air is here, for simplicity, represented as moving in straight lines; but it really moves in curves, and the line of direct motion from east to west is a few degrees north of the equator.

If we suppose the waters of the torrid zone much exposed to the heat of the sun, aided by the dry winds from the land, evaporation will proceed rapidly. Of course, then, the waters at the equator would be relatively lower than those of the other parts of the earth, which would therefore flow toward the equator, and take a westerly course, for the same reason that the air does, subject however to more modification, interruption, and counter currents, inasmuch as it meets with more impediments. I think the currents round the Capes and in the Indian Ocean are perfectly explicable on this hypothesis (theory ?), and I might enter into detail if circumstances permitted.

Yours, &c. G. K. O.

April 17, 1834.

Ericsson's Caloric Engine. By G. K. O. To the Editor of the Mechanics' Magazine.

Sir,—After reading several times the description of Ericsson's Caloric Engine, contained in your February number, I am yet at a loss in regard to some things. Assuming, as the description does, that the air in the part of the engine represented black is under greater pressure than that in the white, but being of nearly the same temperature, it must be of greater density; for example, let the density of one be represented by 50, and that of the other by 100, that is, the quantity of air contained in any given portion of the black is twice that contained in a corresponding portion ot the white part: suppose the temperature in the large cylinder is 480 degrees higher than that in the small one. Now, if 10 cubic feet of air of the density of 100 be admitted into that of 50, it will expand till it becomes of the same density as that into which it is admitted, and occupy nearly 20 cubic feet; and when reduced 480 degrees in temperature, will yet occupy 10 feet. While the large cylinder admits 10 feet of the density of 100, the small one takes out 5 feet of the density of 50, which, though expanded by the heat, would only fill 10 feet of the density of 50; but being admitted into the black part, where the pressure and density is 100, it will become of the same density, and, of course, occupy but 5 feet. If the case be as I have stated, the corresponding portions of the two bodies of air in the black and white parts will soon be brought to the same density by a few strokes of the engine, and (according to the description) the *difference* of density constitutes the motive power. Will you, or some of your correspondents, please explain this difficulty. Yours, &c. G. K. O.

Locomotive Steam Engine.—I send you a brief statement of the performance of a locomotive steam engine, recently built under my direction by Mr. Baldwin, of Philadelphia, and now running on the Charleston and Hamburg Railroad. She started from Aiken, 120 miles from Charleston, on Thursday morning last, at 15 minutes past 7 o'clock, with 11 cars loaded with cotton; at Blackville, 90 miles from Charleston, another load was added; at Midway, 72 miles from Charleston, 2 others were added; and at Branchville, 62 miles from Charleston, a fourth load was added—making in all a train of 15 loaded cars. This immense weight, not less than 80 tons, including engine and tender, was delivered in Charleston, at 7 o'clock 15 minutes, in the evening of the same day, notwithstanding delays on the road, at the different stations, of $4\frac{1}{2}$ hours—making the running time $7\frac{1}{2}$ hours only, for the distance of 120 miles. Numerous ascents of 20 to 35 feet per mile were overcome with this load; and what is of most importance to those interested in railroads, is, that the greatest weight on either wheel of the engine does not exceed $1\frac{1}{2}$ tons. Respectfully, yours,

E. L. Miller.

New Invented Stomach Pump—*Description of a New Form of the Stomach Pump.* By P. B. Goddard, M. D., of Philadelphia. [From the Journal of the Franklin Institute.]

This pump consists of two parts, one of which I shall call the valve box, the other is an ordinary syringe, of good construction, to which the valve box is screwed when in use.

The valve box is a cylinder of metal, containing ovoidal or egg-shaped cavities, equally distant from the centre of the cylinder; at this point a pipe enters, which, when screwed on to the syringe, opens a communication between its cavity and these two cavities in the valve box. Near each end of the cylinder a short and slightly conical tube projects laterally, to which a flexible tube is to be fastened, and which causes a communication between the flexible tube and the cavity in the valve box. Each of these cavities contains a bullet accurately turned, so as to fit the orifices of the tubes, entering into it, and acting as a valve. It will be seen by reference to the accompanying cut (which is a section of the valve box) that if the valve box be held vertically, and the syringe screwed on it, the bullet in the upper cavity will fall upon the orifice of communication between it and the body of the syringe, whilst the bullet in the lower cavity will, in like manner, lie upon the orifice of the tube leading externally. If the lower tube be now immersed in water, and the piston of the syringe be drawn out, it will be evident that the body of the syringe will be filled with water from the lower tube. If now the piston be pressed home, the water will pass out of the upper tube; the bullet in the lower cavity preventing its escape there, just as the bullet in the upper one prevented the entrance of air before. It will then always pump water, or any other fluid, from the lower tube to the upper.

If the position of the valve box be now reversed, and the end which was above be placed below, the bullets will fall by their own gravity into the opposite ends of the cavities, and the instrument will act as it did before, viz. pumping from the lower orifice to the upper, although the relative position of the tubes has been reversed.

To use this instrument, the valve box must be held in nearly a vertical direction. A long flexible tube being passed into the stomach, is attached to one of the short conical tubes, say the upper, and a short tube leading to a basin is then fastened to the lower one. The basin being filled with warm water, and the syringe put in action, the water will pass into the stomach and dilute the poison. When enough has passed in, the syringe is to be turned in the hand, so as to bring the tube down which was before above, without taking off the flexible tubes, or changing them in any way, and the syringe again put into action. The water will be pumped out of the stomach, bringing the poison along with it.

The following are the chief advantages of this instrument. It is perfectly simple in its construction, and not liable to get out of order.

The directions for its use are easily understood, aud as easily remembered.

After the flexible tubes are once adjusted, no alteration is required until the operation is finished.

When the instrument is once put in action, gallons of water may in a few minutes be passed through the stomach, thus washing away every trace of poison and saving many a valuable life.

Fig. 1, section of valve box—*a a*, cavities for the bullets—*b b*, bullet valves—*c c*, tubes, to which are attached the flexible pipes—*d*, female screw to attach it to the syringe

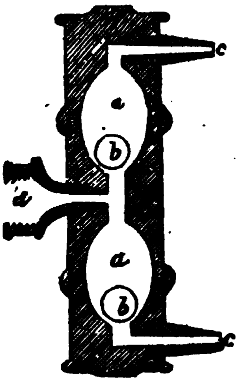
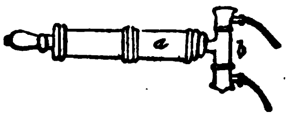


Fig. 2, the entire instrument—*a*, the syringe—*b*, the valve box.



American Patent—*Specification of a Patent for Improvements in the Wheels of Railroad Carriages. Granted to* John Elgar, *Civil Engineer, City of Philadelphia, November* 19, 1833.

To all whom it may concern, be it known, that I, John Elgar, Civil Engineer of the city of Philadelphia, have invented certain improvements in the wheels of railroad carriages, by one of which improvements they are made to adapt themselves more readily to curved roads

than such as have been heretofore used for that purpose; and by the other a construction is given to them which will render them more firm and durable than those now in general use; and I do declare that the following is a full and exact description of my said improvements.

The self-adjusting conical wheel for running upon curved roads is well known to engineers, it having been made the subject of a patent by Mr. James Wright, and a modified form of it being now used on the Baltimore and Ohio railroad. The plan which I have devised is a new modification of this principle, by which some of the inconveniences which have hitherto attended its employment are in a great degree, if not altogether, obviated.

Instead of making the wheel conical on its whole tread, like Wright's, or of forming the conical part against the flanch, and leaving the other part cylindrical, as in those used on the Baltimore road, I form the cone on the outer part of the tread of the wheel, opposite to the flanch, leaving that part of the tread which extends from the flanch towards the opposite side cylindrical, or nearly so, for one half of its width, more or less, and then tapering outwards in such degree as may be most convenient, according to the curvature of that part of the road which has the smallest radius.

The curved part of the road is adapted to these wheels, by widening the track in proportion to the radius of curvature, so as to admit the conical part to roll on the interior rail, whilst the cylindrical part bears upon the exterior rail. This construction obviates the objection arising from the wrong tendency of the cone when running on the exterior rail, and adapts the whole more perfectly to those parts of the road which are straight, and produces other advantages, which will readily occur to experienced engineers.

In order to render railroad wheels more firm and durable than those now in use, I form that part of the wheel usually occupied by the spokes of two plates of iron, preferring for this purpose thick sheet iron of three eighths of an inch, more or less, in thickness. These sheets of iron are raised so as to be concave, or dishing, forming the segments of a large sphere, or, if preferred, they may be made conical. These plates have a hole in their centres to receive the hub, or nave, and have a flanch turned up, over which the hoop of the hub may pass; or, if preferred, the hub may be secured in other ways. If the rim or tire is of wrought iron, the plates may have a flanch turned at their peripheries, through which they may be rivetted on the interior of the rim. When the rim is of cast iron, the plates may be secured without a flanch, one being cast within the rim, on either side, against which the plates may fit, rivets or bolts passing through them and through the flanch, to secure them in their places. Other modes of fixing the plates in their places may be devised, and I do not mean to confine myself to any specific plan of effecting this object, the manner of doing so not in any way affecting the principle upon which my improvement is founded. This mode of construction is particularly adapted to wheels for locomotive engines, that run either on commoh roads or on railways.

What I claim as my invention in my first described improvement, is the making the wheel of a railway carriage conical on its outer edge, and cylindrical between said conical part and the flanch, for the purpose of adapting it to run upon curved roads, and applying it thereto upon the principle, and in the manner herein before set forth.

What I claim as my invention in my second described improvement, is the substituting of metallic plates (generally of wrought iron,) for the spokes usually employed; and the giving to such plates a form which shall be convex, either curved or conical, from the rim to the hub of the wheel. JOHN ELGAR.

IMPORTANT DISCOVERY.—We are informed by two gentlemen who lately passed through Syracuse, N. Y., that Mr. Avery, the proprietor of an extensive iron foundry in that place, has made a very important discovery in relation to casting of iron. The best kind of earth used in foundries is brought we believe from Canada. Mr. Avery analyzed this earth, and found it to contain a certain portion of blue clay. Following this up by a series of experiments, he discovered that if *common fine sand* was mixed with *common blue clay*, in the proportion of one tenth part of clay to nine tenths of sand, it would constitute the best possible composition for casting that he had ever used. Even the most delicate castings came out perfectly free of sand, and required no sort of cleaning by vitriol. He dismissed ten of his cleaners on the spot. Mr. Avery has taken out a patent for his discovery, and estimates that his composition will make an immense saving in the expense of iron foundries—in the diminution of labor, the cheapness of the sand, and in the disuse of vitriol in the process of cleansing. We hope that our neighbors of the furnace will immediately test it by experiment.—[Brattleboro' Independent Inq.]

STRAW WEAVING.—We had the pleasure, a few days since, of witnessing the operation of weaving straw for the manufacture of bonnets, at the establishment in this town, under the direction of Mr. J. P. Golding. There are now employed in this establishment upwards of 100 females, all engaged in weaving the straw into plaits or webs of about two inches in width. The variety of patterns is large, many of them very beautiful. In some the common rye straw of this country is interwoven with the Tuscan straw. The web or warp into which the straw is woven is composed of silk doubled and twisted from the cocoons very fine, but yet sufficiently strong for the purpose. This silk is prepared, as we are informed by Mr. G., by a son of his, who is located in Mansfield, Conn. where for several years past a considerable quantity of silk has been produced. Mr. Golding was formerly a silk weaver in Manchester

England, and his family understood the culture of the worm, the manufacture and weaving of silk, and are said to be in the exclusive possession of this information in this country. Mr. Golding has already invented machinery and woven several patterns of silk vesting and webbing in this country, but at present this part of the business cannot be profitably carried on here. He intends, however, to prosecute the business, and has set out trees for that purpose at Dedham.

We have no doubt that the production and manufacture of silk will become a very important branch of American industry, as many millions of dollars are annually paid for the imported article. We have yet much to learn, but a few years will put the country in full possession of all the necessary information for carrying on successfully every branch of silk manufacture.

We notice by the papers that some silk handkerchiefs have been manufacturad in Dayton, Ohio, under the superintendence of Daniel Roe, Esq. the produce of the native mulberry. Their color is the natural color of the silk, and they appear to be a very durable article.—[Bunker Hill Aurora.]

FANNING MILL.—An ingenious wight, named William Gall, has constructed a pair of self-acting fanners, which, without the aid of man, sift wheat, corn, &c. The simplicity of the invention is astonishing. By a funnel of sheet-iron, the wheat descends upon an iron wheel full of brackets; the wheel is so nicely balanced, that the moment the wheat falls the wheel revolves, and throws the wheat into a pair of fanners on the flat below. On the outside of the iron wheel is a wooden one, and over it is a belt attached to the fly wheel of the fanners, which impels them, and so long as a particle of wheat is left, the machine moves and throws it out.—[Sat. Eve. Post.]

NAUTICAL SCHOOLS.—[*From the Annals of Education.*]—Dear Sir: Amid all the interesting matter touching the cause of education, with which your pages abound, I do not remember to have seen any article on the particular subject of *nautical education.*

It is undoubtedly true that the importance of education in its fullest acceptation, and more especially elementary education, is not duly appreciated by any community on earth—I mean, if we are to judge of the views of mankind by their every day practice. It is however no less true that public attention, in many parts of our country, has been more directly turned to this subject of late, and that great efforts have been made, and are still making, to wake up the benevolent, the enlightened, the patriotic, and the Christian, to the immense and paramount importance of an increased education of the people, who are to decide the destinies of this immense and growing republic. But in looking at a subject in its general bearings and relations, we often lose sight of its particular divisions and the relative importance of its various parts. It has thus happened, probably, that the education of seamen, as a class, has attracted but little attention and interest.

The time was, when all the claims of seamen were dreadfully neglected—when they were used only like the vessels they manned, and the sails they unfurled to the breeze or reefed in the gale, to bear the cargoes of their employers to foreign lands, and return with the produce of other countries to enrich their owners. Under such a state of things, what could be expected of seamen, exiled from society, for the greater part of the time, exposed to hardships and perils unknown to landsmen, with no guide but their passions? Is it surprising, that when released from the temporary restraints of their captains, and from the duties of the ship, they should riot in vice and misery?

Such was the history of seamen, to a lamentable extent, at home and abroad. *At home*, they felt like strangers and outcasts, and were welcomed to no society but that which would enervate their bodies, and pollute and destroy their souls—filch their money, and debase and paralyze all the finer feelings of their nature. *Abroad*, they were induced to seek the vicious indulgences to which they had been trained at home.

But the scene is now changed. American seamen, at least, are beginning to be regarded as men—as immortal—as having rights and immunities, sacred and valuable. Those who have hitherto fattened on their misery, have begun to tremble.

Their claims are heard—thought of—respected; their wants, in a measure, provided for—their morals considered and guarded. Hence we see *Bethels* arising all through the land in our cities, where they may meet to worship God—*Boarding Houses*, where they can resort in safety, and be free from temptation—*Savings Banks*, where they may lay aside their earnings, to provide against age, sickness, and want, instead of ministering to their appetites and vicious propensities; and hence we hope to see *Seminaries* intended and adapted for their instruction in common branches of education, and in nautical science.

I am aware that one or two such schools have been established, and that more are contemplated; but it is highly desirable to call the attention of the public generally to this subject, and to impress them with the importance and the expediency of establishing many such institutions.

It would be unnecessary to detain your readers by any remarks as to the importance of education in the common branches, to any individuals in the community. But I will say that seamen need such instruction especially, and that they are in peculiar danger of being overlooked.

They need it especially. If they are untaught when they go to sea, as too many of them are, pride and shame will tend to keep them ignorant. If they cannot read or write, how many hours at sea will be wasted, that might else be profitably employed! Their minds will be stored with vice and profanity, for lack

of better instruction. But the evil does not stop here. If they are ignorant of the rudiments of knowledge, they cannot learn navigation as a science; and are shut out from all hope of rising above the rank of a common sailor.

They are in peculiar danger of being overlooked. Most seamen go to sea when they are young, and of course, if not early instructed, they are left entirely to themselves for life. Others, of their age, may be also neglected in youth; but change of place, or circumstances, may favor them with instruction in the family, the store, the familiar lecture, or some association for mutual improvement.

Some such system as the following might be adopted to advantage.

1. Let merchants and captains give preference to young seamen who can read and write.

2. Let a nautical school be established in every seaport town in the country; where not only navigation shall be taught at a moderate price to all who desire to be instructed, but connected with which shall be a master devoted to teaching elementary branches of common education.

3. Let merchants, and others interested in seamen, recommend to their crews to resort to these schools, and perhaps pay a bounty to such seamen as bring certificates of proficiency from the instructor.

Should you deem the subject suitable to your work, I shall be happy to furnish you with some remarks from one who has had experience in conducting a nautical school.

A Friend to Seamen.

Internal Improvements, No. V. By F. To the Editor of the American Railroad Journal, and Advocate of Internal Improvements.

Sir,—Animated discussions have at various times taken place, in relation to the particular plan that is best adapted as a general means to promote and facilitate internal commerce; and although systems have been explained, and theories investigated, in the most lucid and elaborate manner, they have been too frequently characterized by party influence, to produce any other effect than that of exciting animosities to the prejudice of the true interest of the cause.

It is not believed that any one particular plan can with propriety be recommended as most fit to subserve the general interest of the country. The circumstances which should govern the mind in the choice and adoption of such plan are principally of a local character, and entirely independent of general rules. Canals, railways, turnpikes, have each their particular province, their particular sphere of action. Each, according to circumstances, possesses, relatively, certain capabilities and advantages, for which it claims precedence over the other two; and for which alone it should be selected as most likely to conduce to the improvement of the section of country it may be intended to benefit.

One of the main causes of error, and one that has been productive of more injury than any other, may be traced to the prejudice that has so unreasonably existed in the minds of the people, against the employment of men of science in the construction of important public works. It is disgraceful to find the interests of men of this class, even when possessing a large share of practical knowledge, prejudiced by the very thing which ought, in the eyes of an enlightened community, to have advanced them; to find their services slighted and put aside, to give place to those who, professing to act independently of all theory and scientific principle, and ignorant of every thing except the few practical rules indispensable in their vocations, happen to enjoy the unenviable distinction of being mere practical men. It is only by the lights of science that we can ever hope to estimate with any degree of accuracy the combined actions of different causes, and by a correct knowledge of its principles that we can avoid making improper applications of established laws, and be enabled to draw legitimate conclusions from particular premises. It is not imagined by any reflecting person that knowledge of this kind can possibly militate against a correct conception of plans, and a judicious arrangement of details. Were it reasonable to suppose, even for a moment, the encouragement of any such ridiculous notions, many convincing instances might be adduced as evidence to maintain the contrary position,—that without its assistance no engineer can hope to attain to eminence in his profession. Prony, Tredgold, and Smeaton, were all, in some sense, practical men; but to an extensive practice they united a profound knowledge of all the different branches of mechanical science; and who have contributed more than they to the general diffusion of knowledge, under the different heads to which their attention was directed. We are persuaded that it is only from the exertions of such men (and many such may be found in this country), that we can possibly escape falling into the snares that are laid by designing men to dupe the unwary.

So much has already been written on the relative value of railroads and canals, that the subject is indeed well nigh exhausted; and although little or nothing, it is believed, can be adduced further to strengthen our position, but what has been hundreds of times reiterated from every quarter of the Union, still it cannot be passed by, consistently with the object in view and in justice to the cause we uphold, without a brief notice of some of the characteristics by which these formidable rivals, if such they must be considered, are chiefly governed. That of friction, as it has proved a fruitful source of disputation among theorists, claims particular attention, as the basis on which most of the arguments are founded; and although the experiments from which our information on this important topic is derived have been conducted with the greatest care and precision, the results differ so widely in character, and present so many material opposing points, that the laws established from the conclusions drawn from the one

have ever been invalidated by those drawn from the other. It was long looked upon as a fundamental principle, that *the friction of rolling and sliding bodies was the same for all velocities*, and consequently, that any body being acted on by a constant force barely sufficient to overcome its friction, together with the resistance of the atmosphere, would, like a falling body acted on by gravitation, proceed with a motion continually accelerated, and increase beyond any assignable limit. However startling this assertion may have been at its first appearance, it yet found many to countenance its introduction, and claim its admission as a truth deserving unlimited credit. Here was a fine field for speculation; and to this apparent paradox may be traced the fountain head from which has emanated all the enthusiastic hopes and extravagant expectations which have characterized the railroad mania during the last few years. Fortunately, however, for the cause of science, men have been found sufficiently sceptical to question the truth of this absurd position. Morin, satisfied in his own mind, that his predecessors, Vince and Coulomb, had been laboring under the effect of some undefinable error, determined to sift the matter until he discovered the cause. Having prepared an apparatus for this purpose, he varied the velocity from the lowest up to ten feet per second; the rubbing surfaces from some tenths of a square inch to nearly five hundred square inches; and the pressures from ninety to twenty-five hundred pounds. All the experiments made within these limits, and they were repeated many times, agree in character, and prove, what is more consistent with our ideas, and reconcileable with our experience, that the friction of surfaces moving on each other is *entirely independent both of velocity and surface, and proportionable to the pressure*. In this experiment, of course, the opposing resistance of the medium through which the body passes is abstracted.

These practical results were still, however, highly satisfactory, as placing the ability to propel carriages on railroads at a suitable speed, for the more rapid dispatch of business, beyond a doubt; and as showing the striking relative difference in the force requisite to produce the same degree of speed upon canals. But before going further, let us examine a little into the nature of this latter resistance. We find this to be governed by totally different laws: that it increases with the square of the velocity. It is the resistance of the medium through which the body passes, and is occasioned by two causes,—the cohesion of the particles and the inertia of matter. Thus, if a body move through a fluid at different velocities, the resistance will increase with the increased number of particles struck in a given time; which, of course, will be determined by the space run through in that time. If, therefore, a triple number of particles be struck, the resistance will be triple; but it increases further with the force with which the body strikes the particles, and this being proportional will be also at a triple rate, making the whole resistance nine-fold: i. e., partly in the ratio of the velocity, and partly in the duplicate ratio of that velocity.

The only apology offered for these tedious and uninteresting details, is the circumstance of their being addressed to the unenlightened—to those whose occupations may preclude them from bestowing much care and reflection upon subjects of this character. It is a desideratum admitted by all who have the interest of the country at heart, that a correct knowledge of fundamental principles be so generally diffused throughout every class of society, that each and every individual member thereof may be enabled of himself to pass judgment on the relative merits and demerits of the various schemes presented for public approbation; and to detect the fallacies of those whose wilful misrepresentations have so often before led into error. Almost every instance that has occurred where serious injury has resulted from ill-advised and ill-concerted undertakings, has been characterized by a total ignorance of the commonest rules of hydro-dynamics. Many unhappy examples might be adduced to illustrate this observation, but we forbear, in the hope that the experience derived from the past will so regulate the actions of the future as to render their recurrence, unless wilful, next to impossible.

But to return to our subject. It appears from the different nature of these resistances, that the rate of velocity on canals is confined to a very low limit, whereas the rate of that on railroads may be increased to any height that will not prove injurious to the road and carriage. On the other hand, however, it is to be remarked that this very principle, which is harped on as an insuperable objection to the further use of the canal, actually endows it with advantages that are altogether unattainable on railroads. We shall endeavor to explain this in as few words as possible. The relative good effect produced at different velocities, in round numbers, stands very nearly thus: One to three in favor of canals at a velocity of two and a half miles per hour; equal at a velocity of five miles per hour; and one to three in favor of railroads at a velocity of ten miles per hour. Now, reasoning from these premises, it can be made to appear that a force of traction on a canal equal to one hundred pounds will be amply sufficient to move a mass equal to ninety thousand pounds. A horse travelling at the slow rate of two miles per hour can draw with ease thirty tons in a boat weighing fifteen tons. This gives us at once a proportion of one to nine hundred as the amount of resistance opposed to the motion of a vessel through the water at two miles per hour. Now, reducing this velocity to one mile per hour, the proportion becomes one to three hundred and sixty; and if to a half a mile per hour, one to fourteen hundred and forty; or, in other words, a traction equal in force to 100 lbs. can thus at that rate draw a mass of the enormous weight of 1,444,000 lbs. This as-

tonishing fact does not only exist in theory, but has actually been proved in practice, upon our own lakes. A single horse has been known to draw, at the rate of one mile per hour, a raft weighing two hundred tons. F.

On Railroad Wheels, &c. By Wm. M. Cushman. To the Editor of the Mechanics' Magazine and Register of Inventions and Improvements.

Sir,—There are few applications of science which make such continual and importunate calls upon its resources as the subject of railroads—its principles having place as well in the minute, as the more prominent parts; and to such an extent does this obtain, that, although casuists might dispute the endowment of sensibility, we may with some propriety credit the "sympathy" which subsists among its various constituent parts.

To those of your readers who know the important part the appendage, which forms the subject of this paper, acts in the successful operation of a railroad, no apology for its appearance would be proper or necessary. Impressed, however, with the belief that, in matters of science, nostrums and secrets are the peculiar property of empiricism, I am persuaded that liberality, to a certain extent, among engineers, in a mutual interchange of ideas through public journals devoted to such objects, will be attended with the most beneficial results to the profession and its members generally—it is the hope of contributing a trifle to such result, which induces me to send for publication, the subsequent compilation from my common-place book.

The problem assigning to the parts of the wheel the proportions requisite to sustain a given stress, has been investigated;* but as I have never seen any discussion touching the particular distribution of metal to obtain the requisite strength with *the least quantity of metal, and at the same time to offer the least resistance to motion*, after briefly reciting the mode of proceeding in order to attain the single condition of strength, I propose to examine that necessary to the attainment of the latter conditions.

To determine the dimensions of the rim, arms, &c., consider them rectangular prisms, calculate the stress these prisms will bear; and lastly, dispose them in the best form for strength and motion on the various parts of the line.

Each arm must be of sufficient strength to bear the greatest stress that can ever fall upon it, which is half the weight of the car and its load; then this formula holds,

$$\frac{S}{2200} = a; \ (1.)$$

in which S is put for half the weight, and a for the surface in inches of the section of the arm.

In the rim this formula holds,

$$t = \sqrt{\frac{c \times S}{850 b}}; \ (2.)$$

in which c = the length of the arc between the arms, *in feet*, at the mean diameter of the rim; S, as before; b = the breadth of the rim, *in inches*; and t = the thickness of the prism, *in inches*—to be disposed in the best form for strength and for the rim. The formula (2) is general, but the other is affected by the number of arms; it is designed for a 3 feet wheel, having 10 arms, or a 5 feet wheel, having 12.

But since, in rolling bodies, *each particle of matter resists motion in proportion to the square of its distance from the axis of motion*, it is evidently an object of the first importance to dispose of the weight of metal as near the axis of motion as is consistent with strength, safety, and the perfection of the wheel in other respects.

To illustrate the effects of this principle, let the weight of a car and its load be 3 tons, and suppose further, that a wheel of 3 feet diameter is the height most suitable for the road it is to run upon. Now, if it be desired to sustain a given *constant* weight by a prism of a given breadth, supported at each extreme, it is manifest that, as the distance between the supports is increased, the depth of such prism must likewise be increased in a certain ratio; and vice versa. This condition is expressed in formula (2,) in its true ratio—hence, in increasing the number of arms, we diminish the weight of the rim, and effect a transfer of metal towards the centre of motion; and this may be done without injury to the wheel in any respect.

I shall in the first place assume formula (1) to be general, to illustrate the effect resulting *solely* from the *change of place of the metal from the exterior towards the interior*.

Excluding the part of the radius occupied by the nave and rim, the quantity of metal for an arm will be 19.92 cubic inches, and on the hypothesis of 10 arms, the surface of a section through the rim will be 4.090 inches; but on the hypothesis of 9 arms, the sectional surface is 4.315 inches: hence the volume of the rim for 10 arms is less than that for 9, by 25.5 cubic inches.

These preliminaries made, in order to effect a comparison of the efficiency of the two wheels:

Let the prism representing the volume of any arm be divided into an *indefinite* number of equal parts, by planes cutting it orthogonally, and m = one of these parts; let also r, r', r'', r''', &c., ad infinitum, be the respective distances of these quantities from the axis of motion, and x = the sum of the rectangles of the subdivisions into the squares of their respective distances from the axis: then, by the law, we get

$$mr^2 + mr'^2 + mr''^2 \text{ \&c. ad inf.} = x;$$

* Vide Tredgold on Railroads. Science is deeply indebted to this author: his work on railroads, however, published in their stinted infancy, although in many particulars sound, is in others behind the age; it has the merit of having been a pioneer—of having deracinated by a rigorous application of scientific principles, the absurdities which at that period entangled the subject. It is in our own country that many of its most important principles have been developed, with a rapidity corresponding with the fertile genius of our countrymen, and the impetus and zeal every object to which they direct their attention receives.

which expression, since each term is affected by the same quantity m, becomes

$$m(r^2 + r'^2 + r''^2 \text{ \&c. ad inf.}) = x; \ (3.)$$

In assigning a value comparatively small to m, we shall have for all practical purposes the value of x: thus, let $m = \frac{1}{36}$ of the mass of the arm, which (taking the diameter of the nave 5 inches, and considering the last half inch of the arm merged in the rim,) is represented by 19.92: then, r, r', r'', &c. become 1, 2, 3, ... 36; and,

$$\frac{19.92}{36}(6^2 + 7^2 + 8^2 \ldots . \overline{35}) = 9864. = x. \ (5.)$$

Again, since the matter in the rim lies in a circle described about the axis, it is at every point equally distant from the axis; its mass, therefore, drawn into the square of its distance from the axis, will be its moment of inertia: hence,

$$\overline{36}^2 \times 25.5 = 33048 = x'; \ (6.)$$

Wherefore, the *relative resistances to motion of the means used to attain the same end*, in the two wheels, are as

$$x : x' :: 1 : 3.35.$$

2d. But the mass of each arm may, in general, be diminished in the ratio of the increase of number to that contemplated in formula (1,) in consequence of conditions entering therein.

The value of x (form. 5) is reduced by the addition of a single arm, $\frac{1}{9}$ for each arm; their sum being 9, gives x for the total diminution in resistance to motion offered by each, which in amount is just sufficient to make the new arm; whence the relative moments are as

$$x : x + x' :: 1 : 4.35;$$

if the number be increased to 11, the relative moments stand thus,

$$1 : 6.94;$$

if to 12, thus,

$$1 : 9.62;$$

and so on for a greater number.

Such are the results when the principle of momentum of inertia enters as a condition in the determination of the problem.

Extending this principle, we see that the wheel of greatest efficiency with the least quantity of metal would be one without spokes, i. e. having a sheet of metal extending from the nave to the rim: but the limit to the number of arms will be attained when the rim has such a thickness that, when further reduced, there would be danger of fracture from other causes than the stress it is to bear.

I shall not extend my remarks further. By those acquainted with subjects of this nature, the consequences which flow from them will readily be appreciated. My aim has been not to define with precision the exact form necessary in practice, but to illustrate the importance of introducing the principle of momentum of inertia; and to indicate, in a general manner, the changes which ought to be made in the ordinary form, from its introduction.

WM. M. CUSHMAN, C. E.

Albany, April 14, 1834.

Dip, Declination and Variation of the Needle in the United States. By A CITIZEN OF NEW-YORK. [From the Railroad Journal.]

If the manufacturer of compasses in Birmingham, England, will be so polite as to send to Dr. Smith, 28 Water street, New-York, two of his needles, that stand alike in their directive course for three days successively, he will then answer the question put by him in the Railroad Journal, of March 22d, 1834; for he never has seen two needles, which were imported from England, that stand alike for that length of time.

MALT AND TEA.—It is a curious fact, that the consumption of malt in England and Wales has been *stationary* for nearly half a century, though the population has more than doubled during that period. [M'Culloch's Commercial Dictionary, p. 728.] The tables, however, show that the public brewers, since 1787, have contrived to manufacture *one-third more STRONG beer out of the same quantity of malt!* So that both the quantity and quality of the national beverage have declined. The consumption of genuine tea has also been steadily declining, compared with the population. The sales of the East India Company show that the average consumption per head of *their* teas in 1801, was 1 lb. 13.6 ounces; in 1831, per head, 1 lb. 9.2 oz. showing a decline of full 17 per cent. during the last thirty years. As the fashion of tea-drinking has certainly not declined, it may be concluded, even after allowing for the increased consumption of coffee, either that the decoction has been made weaker, like beer, or that the shops have sold something else in place of the Chinese plant. The numerous convictions of persons having adulterated tea in possession favor the latter conclusion. Monopoly and high duties have operated unfavorably on public morals. "Lovers of tea or coffee," it is truly remarked, "are rarely drinkers:" and Raynal ascribes the sobriety of the Chinese to the use of these grateful beverages, which produce all the good, without the evil consequences, of more powerful stimulants.—[History of the Middle and Working Classes, second edition.]

THE NUMBER FIVE.—The Chinese have a great regard for this number. According to them there are five elements—water, fire, metals, wood, earth; five perpetual virtues—goodness, justice, honesty, science, and truth; five tastes—sourness, sweetness, bitterness, acidity, and salt; five colors—azure, yellow, flesh-color, white, and black; they say there are five viscera—the liver, the heart, the lungs, the kidneys, and the stomach. They count five organs of the senses—ears, eyes, mouth, nose, and eyebrows. A Chinese author has written a curious dialogue between these senses. The mouth complains that the nose is not only too near, but above her; the nose in reply defends its position, by stating that but for it the mouth would eat stinking meats. The nose in turn complains of being below the eyes; they reply,

that but for them men would often break their noses.—[Le Lanterne Magique.]

Dr. Majendie's Observations respecting the Pulse.—Majendie has given a scale of the pulse, which shows that the difference in frequency between that of the infant and the aged is more than double. The scale is, at birth, 130 to 140 a minute; at one year, 120 to 130; at two years, 102 to 110; three years, 90 to 100; seven years, 85 to 90; fourteen years, 80 to 85; adult age, 75 to 80; first old age, 65 to 75; confirmed old age, 60 to 65.

Curious Astronomical Theory.—We state the following on the authority of M. Arago, an eminent French astronomer: If we place in a horizontal line the series of figures of which the law is evident—

0 3 6 12 24 48 96 192

(each double the preceding,) and afterwards add 4 to each, we shall have a series denoting the relative distances of the Planets from the Sun, thus—

4	7	10	16	28	52	100	196
Mercury.	Venus.	Earth.	Mars.	*	Jupiter.	Saturn.	Uranus.

If 10 represents the distance of the Earth, 4 will be that of Mercury, 7 Venus, 16 Mars, and 52, 100, and 196, the respective distances of Jupiter, Saturn, and Uranus. This law was known as far as 100, before the discovery of Uranus: and the distance being found to correspond, affords a very remarkable confirmation of its truth. But it will be observed there is a deficiency of one term between Mars and Jupiter. This led philosophers to suspect the existence of a planet at the distance required to fill up the vacancy; and in 1801, Piazzi, of Palermo, actually discovered one, whose orbit was between those of Mars and Jupiter, and nearly at the proportional distance of 28 from the Sun. This planet was named Ceres; and since that period three others have been found—Pallas, Juno, and Vesta—all of which have their orbits so near each other as to lead astronomers to believe that these are the fragments of a larger planet, which had been shattered into pieces by some internal explosion, or the shock of a comet.—[London paper.]

Sir John Herschel.—In a recent sitting of the Academy of Sciences, the gold medal, value 650 fr. bequeathed by Lalande, was adjudged to Mr. (Sir John) Herschel, for his discoveries relative to double stars.—[Moniteur.]

Entomology.—An Entomological Society, organised during the summer, held its first meeting last month in Bond Street. The butterflies belonging to that quarter will therefore do well to beware. Mr. Children, Mr. Kirby, Mr. Spence, and some of the best pinners of the day, are members.—[London paper.]

METEOROLOGICAL RECORD, KEPT AT AVOYLLE FERRY, RED RIVER, LOU.

For the month of February, 1834—(*Lat.* 31.10 *N.*, *Long.* 91.50 *W. nearly.*)

Date.	*Thermometer.*			*Wind.*	*Weather, Remarks, &c.*
1834.	Morn'g.	Noon.	Night.		
Feb'ry 1	28	54	50	calm	clear—white frost—clear all day and night—Red River rising
" 2	31	57	54	"	" " " " " " "
" 3	38	66	60	"	" " light " " " "
" 4	41	70	56	"	" —clear all day and night
" 5	46	74	61	"	" " "
" 6	50	74	43	"	" " "
" 7	51	73	68	"	" " "
" 8	60	73	69	"	" —cl'dy morn. " "
" 9	54	66	63	"	" " "
" 10	47	74	68	"	" " "
" 11	60	73	64	"	" " "
" 12	50	77	71	"	" " "
" 13	50	76	70	s—light	" " "
" 14	53	75	73	s—high	cloudy morning—clear day—cloudy morning
" 15	60	51	51	w	" all day
" 16	48	51	50	calm	" " —night clear
" 17	42	68	61	"	clear—white frost, (*light*)
" 18	48	66	63	"	" —cloudy night
" 19	61	66	66	"	cloudy—foggy morning—thunder and rain all day and night
" 20	68	74	74	"	" all day
" 21	70	78	74	s—light	" " —martin birds appeared this evening
" 22	70	78	75	"	" " —lettuce fine and large
" 23	70	74	73	"	" —showers all day and night
" 24	71	76	66	"	" —evening wind N
" 25	52	54	46	N—high	" all day and light showers
" 26	48	45	45	N—light	" and light showers
" 27	44	46	45	calm	" —rain all day
" 28	45	53	49	"	" —night clear

Red River rose this month 2 feet 3 inches—below high water, 5 feet 6 inches.

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 25 cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*.—John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FOR THE WEEK ENDING APRIL 26, 1834. [NUMBER 4.

Other things may be seized by might, or purchased with money: but knowledge is to be gained only by study, and study to be prosecuted only in retirement.

HANCOCK'S WEDGE WHEELS.

Fig. 1.

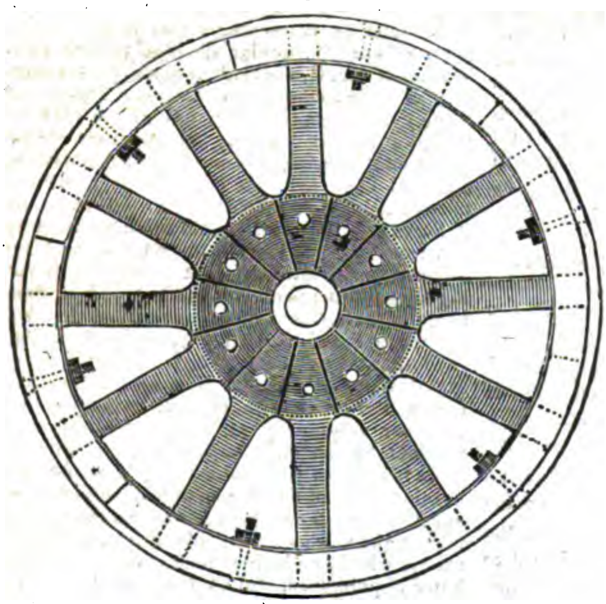
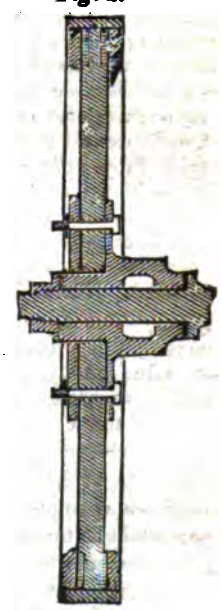


Fig. 2.



Hancock's Wedge Wheels. [From the London Mechanics' Magazine.

SIR,—I forward you a sketch and description of the wedge wheels which I have adopted for my steam carriages, having found those of other constructions insufficient for the purpose. Being desirous of employing vertical wheels, and knowing that those on the common plan could not stand in this position, I determined on trying a pair constructed in the manner I am about to describe, and which description I am induced to send you, from a belief they may be found useful generally, and more particularly to those who are engaged in similar pursuits with myself.

Fig. 1 is a front view of a wheel, with the front bindplate removed, to show the meeting of the wedged spokes, which are of straight grained, well seasoned ash, tenoned into the felloes as in common wheels,

3

but the nave ends are very accurately fitted to each other in radial joints, butting against the iron box of the axle, and forming around it, to the circumference of the bind-plate (shown by a dotted circle), a solid connection of timber.

Fig. 2 is a horizontal central section of the above. The tire is secured by a bolt and nut, or rivets, through each felloe, the heads being countersunk, so as to stand flush with the outside of the tire. The box,

which contains a reservoir for oil, is formed with its flange in one casting, the outside diameter of the flange being the same as that of the front bind-plate, which is like a large wrought iron washer, and shown detached at fig. 3.

Screw bolts pass through the back flange, spokes, and front bindplate, the nuts turning against the face of which brace all together as one solid nave. There is one of these bolts to each spoke, as shown in figs. 1 and 3.

The spokes throughout are of a parallel thickness, as shown in fig. 2, the edges being slightly rounded off.

I have not entered into the details of the substance of metal and wood, as this must necessarily depend upon the size of the wheel, as well as the work it is required to perform. Having worked many such wheels on my carriages, I can say, from experience, that they are all that can be required in a wheel; they combine permanent strength with comparative lightness, and are by no means expensive in their first cost.

I am, sir, yours, &c.

WALTER HANCOCK.

Stratford, Essex, January, 1834.

P. S.—The Infant has a set of *dished* wheels on this principle, now in good condition, after having performed work which would have worn out two or three sets of wheels of the common construction.

NEW ERA OF STEAM POWER.—Mr. BURDEN is progressing rapidly in the construction of his boat; it will be in operation on or before the first of June, and we have no doubt will realize the most sanguine expectations of the *inventor* —if inventor we dare call him, for, as will be perceived from the annexed communications, there are several who set up a previous claim. But, as a contemporary well observes,— "Other men broke stones before MACADAM, but HE broke them to such effect as to be justly deemed an inventor. Other men, in like manner, may have observed the extreme buoyancy of the barrel before Mr. Burden; but the successful application of these principles we do think should entitle Mr. Burden to the title of inventor."

We have received the following from MR. HARRIS, in reply to ARCHIMEDES, published in our last number.

NORFOLK, Va., April 12, 1834.

SIR,—I have read with no little amusement, in your last number, a communication relative to my Twin Boat, by a writer who signs himself Archimedes. As he manifests a very laudable desire to prevent people from being "imposed upon by plausible appearances," I have been induced to present for his consideration, through the medium of your valuable journal, some few facts and views which I have no doubt will disperse from his mind the mists of error by which he now appears to be so completely and unconsciously enveloped, and enable him hereafter to direct with the confidence of truth the patronage of "persons possessing both the means and disposition" to patronise valuable improvements. As in my letter, published in your last number, I have publicly condemned Mr. Burden's boat, I deem it proper to state here that I did not intend that letter for the public. Had that been my purpose I should have made no particular allusion to Mr. Burden's boat, but should have left the public to make their own comparisons. I would not be understood as condemning that letter on account of such particular allusion, (for the publication of Mr. B.'s invention made it a fair subject of public discussion, however rigid,) but merely as intimating that, having no wish to make strictures publicly on any man's concerns, and especially to commence a discussion, I should have been for that reason unwilling to have singled out Mr. Burden's invention, as if for the purpose, it would seem, of inviting controversy. My agent, to whom, and for whom alone, I intended that letter, not knowing my sentiments on this subject, judged that, as an advertisement of my invention, that letter would serve a good purpose, and on that account, and not with a view to the injury of Mr. Burden, published it, being perfectly justified in the act by the general principle, that whoever voluntarily introduces his opinions, conduct, or concerns, to public notice, renders them ipso facto justly amenable to public discussion, and in that sense public property, respecting which any man possesses the indubitable right of expressing his opinions, temperately, whether adverse or otherwise. As that letter is published, and as the remarks of Archimedes call for a reply, I am now, of course, compelled to sustain, as well as I may, by all fair means, my unfavorable opinions of Mr. Burden's invention, which I shall do, entertaining not the least personal hostility against that gentleman, with whom, in fact, I am unacquainted and whom I never saw. If Mr. Burden's plan of constructing twin boats is superior to any yet discovered, Archimedes may rest assured that a comparison of it with mine will redound to the advantage only of Mr. B.

Archimedes denies to me the merit of invention, because it appears that a Mr. Simon Fairman, in 1817, at Middletown, in Connecticut, made a very "wonderful discovery" of what was, all persons must allow, according to Archimedes' statement, a "wonderful" boat indeed. This boat of Mr. Fairman's, only 35 feet long, was, it appears, sufficiently buoyant to carry men enough to propel it at the rate of *considerably more* than five miles per hour, carrying also the weight of passengers, their baggage, &c.

Now, sir, this boat could not have been "in all respects precisely" like mine, for had it been

constructed on my plan it would not have been sufficiently buoyant to have carried all the weight above mentioned, and have ventured in to the sound, because its length (35 feet) would have of necessity rendered its other dimensions altogether too contracted for that purpose. What is called a six knot sailing breeze would have raised a sea sufficient to have subjected the passengers and workmen to a rather disagreeable and continued cold bath of several inches on deck; and as for cabins, not one fourth of a moderate number of passengers could have stowed themselves in the narrow and shallow holds of so small a twin boat as one built on my plan, only 35 feet long, must of necessity have been. Why, sir, a boy of eight years only could not have sat upright in one of them. But I do not by any means rest on this difference in proportions as a proof that my invention is one sui generis and not identical with Mr. Fairman's boat. That difference, although in itself strong, is comparatively my weakest point, and on that account I present it first. Had I, after splitting, as it were, a single boat apart, left the inner, or, as A. terms them, "approximate"* sides, perpendicular, I should have arrived but half way to the completion of my invention. I found by inclining those sides at a very considerable angle towards each other, either in a right lined or curvilinear angle, that many various and important advantages were thereby attained, without losing the advantages resulting from the longitudinal parallelism of those sides. This inclination destroyed their vertical parallelism to each other, and thereby rendered the boat essentially different in *form* as well as in *properties* from Mr. Fairman's or any other kind of boat.

In my published letter I did not even mention the curvilinear inclination, for wishing to illustrate my plans by figures, I perceived that no figure which I could draw would be likely to convey a correct idea of that peculiar form, but, on the other hand, would rather be apt to create the impression that I had resorted to something like the five mile "swell" of which Archimedes speaks. That my agent might obtain a full and clear understanding of my invention, I went regularly to work and first built on paper a single boat, of such dimensions, be it observed, that she would be rendered by them, *as a single boat*, entirely useless. I then proceeded to divide her, and by the division made the straight inner sides perpendicular. Before altering this perpendicularity, I proved her to be superior to Mr. Burden's boat, on account of the straightness of the inner sides being "a principal point of superiority." In this particular, a *half stage* only to the completion of my invention, it appears that Mr. F. had preceded me, though it would seem in so *inefficient* and *imperfect* a manner as to cause him to condemn it and resort to *curved* inner sides. It appears that he preceded Mr. Burden in building *twin* boats, and therefore, on that ground, (namely, their being twins,) may as well dispute the merit of invention with Mr. B. as with me. These (Mr. F.'s) inner sides, by being ultimately *curved*, exactly resembled Mr. Burden's, but even in their original perpendicularity they were essentially different from my inclined sides, both in form and properties. It will not do for Archimedes, or any one else, to say that Fairman's boat was composed *of timbers and plank*, and therefore not similar to Burden's, which is composed of *staves*. The *materials* have nothing to do with the question, but the *form* only. I may with as much propriety build a commonly modelled boat of tin, and then get out a patent to prevent people from building such modelled boats from wood. If Mr. Burden chooses to build vessels from coopers' ware, and get out a patent for a new application of staves, why, let him do so; but he certainly cannot prevent men from using the common materials of vessels in constructing *long*, *narrow*, *shallow*, twin boats, having *curved* inner sides. I claim to have invented the *right lined* and *curvilinear inclined* inner sides as an "important and original improvement"* on the straight parallel inner sides, which latter resemble mine only in their straightness and parallelism to each other.

After having proved in my published letter the superiority of the *perpendicular*, straight, parallel inner sides over Mr. Burden's *curved* inner sides, I then brought forward the inclination, which, I take pleasure in informing Archimedes, is a great *distinctive* and original merit of my invention. If Archimedes desires it, I can send him a copy of my specifications, in which I distinctly state that, "*as an original and important improvement, the horizontally straight perpendicular inner side of each twin can be inclined at any desired angle;*" and then proceed to lay down the various advantages obtained by this inclination, from which he can perceive that I do not consider the straight *perpendicular* sides as any thing very superior, though he can perceive from my published letter, and I now repeat, that I think them far superior to Mr. Burden's curved inner sides. Did I suppose you would allow room enough in this number of your journal for the subsequent matter of this communication and for the advantages, and their reasons, resulting from the *inclined* under sides, I would give them now. However, if A. desires it, he shall have them in a future number.

I would inform Archimedes, as a further distinguishing mark of *originality*, that in proportion as my *crescent-shaped* keels rise from a horizontal line they have a certain *lateral* inclination, such inclination being proportioned to the inclination of the inner sides; by which contrivance no curve is created on, but perfect parallelism of the inner sides is preserved.

---

* Strictly they are not approximate, for the two sides of either *one* of the twins being nearer to each other than the inner side of one twin is to that of the other, are, of course, what would come under the term "approximate," from the very derivation and meaning of that word. I grant that the reader of A.'s remarks would know by the term "approximate" that he means the inner sides, because he speaks of their peculiar characteristics, straightness and parallelism; still, the term used as A. would is not correct

* The very words of my specification

This lateral inclination of the keels, as they rise fore and aft towards each extremity, would cause a person, not critically viewing the matter, to suppose that the space between the twins at the centre would be greater, or wider, than that at either extremity; but an ocular examination of a model, (which my agent will with pleasure exhibit,) need only be made to prove that the parallelism of the inner sides could not otherwise be preserved, and that the space referred to is not wider than that at either extremity. Were the keels horizontal, or level, then not they, but the stem and stern posts only should be laterally inclined. Properly speaking, my boat has no stem and stern posts, for the pieces of timber which in common vessels would form those parts, are in my invention nothing more than a continuation and portions of my *curved* and *laterally* inclined keels. I have now, Mr. Editor, I think, fairly and clearly proved that my invention is a different thing altogether from Mr. Fairman's; and any man who, after reading the foregoing matter, would say that it is not different, and at the same time assert that Mr. Burden's invention is different from Mr. F.'s "swell" boat, would not excite the least surprise in my mind, if he should forthwith seriously set about proving that the moon is made of green cheese. But I have not done with Mr. Fairman's boat: I must sail a few miles further in her, and fully test her qualities.

It plainly appears, from the astounding "swell" mentioned by A., that there must have been some radical malconformation in Mr. F.'s boat not made public, perhaps unknown, by A.; for were it otherwise, Mr. F. never would have applied an obstruction to speed, and a cause of dead or back water, for the purpose of *diminishing* back-water. I say obstruction, for no man will have the hardihood to assert, that two boards set on edge, perpendicularly, in the water, whose ends at each extremity are at equal distances apart, but whose centres are sprung or bent in towards each other, can be moved in the direction of their length with a facility equal to that of the same boards when perfectly parallel from end to end. Yet a man who asserts that the "swell" *increased* the speed of Mr. F.'s boat, makes a much more unreasonable assertion.

Archimedes must not misunderstand me. I do not mean that he asserts what he does not believe, but I mean to say that the increase of speed could not have been the result of this swell, but of some other cause not observed, or not now recollected by Mr. F. Another glaring absurdity is involved in the assertion that Mr. F.'s swell increased the speed of his boat. Any person in the least acquainted with the subject must be aware that, of two boats having equal draft of water, the one which is *wider* will not under the same power move so fast as the other and narrower boat. Now, sir, Mr. F., besides partially choking up the straight passage between his twins, *adds* to their width by applying his swell, and yet, through his friend A., tells us that in consequence thereof his boat moved faster!! I do not call in question Mr. Fairman's veracity, or impute to him a designed omission of any particular necessary to be known in arriving at a correct understanding of his invention; but I must be allowed to suggest, whether he has, after the lapse of seventeen years, called to mind *all* the particulars of an experiment, which, it appears, after all, resulted in proving his invention to be useless. His friend A. evidently believes, and endeavors to prove, that it was a failure, for he says it was "previously like" mine, (but "I wish to inform him that he is completely mistaken, and he could not be more so;") and the whole drift and scope of his argument goes to prove (in *his* estimation) that my invention will not succeed.

If he thinks it is so manifest a failure, I think he pays, by arguing on it, no great compliment to the northern capitalists, a body of men of whose intelligence and general information I have always entertained so high an estimate as to suppose that no addition could be made to their ideas by the slight amount of argument which A. has deemed sufficient to expose the futility of my plans.

Some of the *facts* stated (no doubt sincerely) by Archimedes, are in direct opposition to previous and subsequent experience: the cause of back-water, the result of the "swell," and the comparative resistance experienced by the inner and exterior curves, being instances.

If *all* the particulars of Mr. Fairman's experiment have been recollected and told us, and if there has been no mistake, then, sir, I stand prepared to prove, that a hollow tin cylinder, perfectly open at both ends, will move on end horizontally through the water with more difficulty than a common tin tunnel in the same position, whose mouth or larger orifice shall be the forward end, and in diameter equal to that of the cylinder.

The fact is, that enough, fully enough, has been stated by Archimedes, to prove that Mr. Fairman's useless invention was nothing more than a division into two parts of a single boat of the usual model and proportions. Archimedes does not tell us how fast Mr. F.'s boat moved before the application of the wonderful swell, although he says the average gain resulting from the swell was *five* miles per hour; but, allowing, for arguments sake, that this swell was no obstruction, still no man in his senses can believe that the gain was ten per cent. on the original speed. Allow this gain, however, and by calculation we find her *improved* speed was just 55 miles per hour!! As a low rate of increase produces such astounding results, we will endeavor to get this famous boat out of difficulty by supposing the gain to have been equal to the incredible quantity of 50 per cent. and we then find that her ultimate speed must have been 15 miles per hour!

This will never do: we will therefore make one more effort to bring her within reasonable bounds as to actual speed, by going *out of* all reasonable bounds in assigning her increase of speed, from the application of this unmanageable swell, to have been 100! per cent.; yet, allowing the increase to have been this, I may

safely say, physically impossible quantity, and we then find that Mr. F.'s boat moved at the rate of 10 miles per hour, a velocity equal, if not superior, to the rates of any steamboat of that day, and which should therefore have been immediately instrumental in covering our waters with Fairman's *swell* boats, worked by men or horses. What the Connecticut people could have been about, when they permitted such an invention to slip through their fingers and be carried to Demerara, I cannot conceive, for it certainly must have been amongst Connecticut vessels a *swell* dandy of the first order. At all events, Archimedes, who alludes to my prudence respecting my heirs, must allow that Mr. F. did not manifest the usual prudence of the sharp-witted New-Englanders, when he sold so *valuable* a boat for the pittance $300, and took no further steps for the benefit therefrom of himself and heirs. Archimedes has put his friend between the horns of a most provoking dilemma. Should he state the gain resulting from the "swell" to have been within any reasonable bounds, say 5 to 10 per cent., he virtually asserts that the improved speed of the boat was 55 to 105 miles per hour!! If, while advancing through the air at such a rate, he should be able to catch his breath and tell us that this astonishing speed is imaginary, and the result only of stubborn, unbending arithmetic, and that the actual velocity of the boat was only 8 or 10 miles per hour, he thereby makes the incredible statement, that this magic swell conferred a gain of 100 to 166 per cent.!! Why, sir, had I been the proprietor of that "wonderful" boat, I should have gone on *swelling* her at so swelling a rate, that in my exultation, not recollecting the well known catastrophe of the frog *aping* the ox, I should have probably paid so little attention to her powers of endurance as to have absolutely caused her explosion into thin air. With respect to the back-water mentioned by A., I will inform him that it could not by any means have been created by the straight *unobstructing* sides. Does not A. know that back-water is caused by *obstructions?* If he needs explanation, I beg to refer him to "Observations on the Prevailing Currents of the Ocean," as published in your last number, and he will there find the subject handled in a masterly manner, and I trust to his satisfaction. The hollow in the water which he alludes to, with the evident intent that the reader should consider it as a result of the straight sides, was caused by the action of the wheel, and was by no means an evidence of back-water. He ought to know that all paddle wheels, revolving in the water, create waves, and of necessity hollows, and that hollows resulting from such a cause are no evidence of back-water. He, or rather Mr. F., saw the hollow; and A., without further ceremony, assumes it to have been back-water.

I have now done, Mr. Editor, with Fairman's famous swell boat, unless, indeed, some one of the water gods should buoy her up to the surface, and by putting her in my way render it necessary for me to run her down again.

I have, sir, more than once in my life, had occasion to observe how very easily a false issue can be made up on any subject, and the weaker side of an argument be thereby made to appear the strongest. This remark is called forth by the "best way to decide the point" of strength between Mr. B.'s and my inventions, as suggested by Archimedes. I will grant, to his utmost desire, that arches are stronger than angles, and that a barrel will resist external pressure longer, and of a greater amount, than a box would, made of the same kind and quantity of materials. Granting all this, I still assert, with perfect confidence of its truth, that my twin boat, (that is, the *whole* fabric,) can be constructed vastly stronger than Mr. Burden's, and would in consequence be enabled to endure firmly and uninjured the severity of a gale at sea, which would be sufficient to rend Mr. B.'s twins asunder, and scatter them and their superincumbent cabins and fixtures on the surface of the waters. I said a false issue can be easily made up, not meaning that Archimedes would designedly do so. He, I have no doubt, is fully persuaded in his own mind, that the barrel and box test decides the question, and is not aware that when he proposed that test he was making up a false issue. The question is not whether *one* barrel thrown into the water is enabled by its circular or arch-like form to endure greater pressure therefrom than *one* box, but whether two barrels can by any possibility be *connected* externally in a manner better to resist the violent tendency of the waves to separate them than two boxes: said boxes, please to observe, having the advantage of stout internal frames, *upon* which the exterior planks are secured, and the connecting pieces or timbers of which boxes are not secured upon those planks, but inserted through them into the boxes, and forming part and parcel of those frames. Were my twins formed merely of the exterior planking, having no keels and timbers, or internal frames, I would by no means assert that *one* of them would be in itself stronger than one of Mr. Burden's, and better able to resist the compressive power of water. But whoever heard of any the least detriment happening to vessels as now usually constructed with keels, and timbers, from compression of the water. Why, sir, this unalterable property of water is a source of safety to vessels properly put together, for were it suddenly to be annihilated, and its other properties still exist, every *freighted* ship on the ocean would be so much ruptured by the expansive weight of her cargo as to soon go to the bottom. Whether *one* of Mr. Burden's twins is or is not able to resist the compressive power of water better than one of mine is a question in which no one can take any interest, until the heretofore immutable laws of nature become so altered that the power in question shall be able to crush together the two sides of vessels as now usually built. When that period arrives I think it will be time to discuss the question, and I am strongly of opinion, that I should find ample ground upon which to uphold the keel and timbers, (that is,

the *back-bone* and *ribs*,) the knees, braces, and planks, against mere planks alone, whether those solitary planks are put together arch-like or otherwise.

If Mr. Burden pierces his twins, (thereby, observe, injuring the arch principle of his invention,) and introduces therein frames similar in any respect to keels and timbers, or to any thing else, into which he would secure his connecting timbers, he does just what I do, and therefore cannot connect his twins by that means stronger together than I do mine. But, as I am informed, and agreeable to the published description of his boat, he does not introduce frame work within his twins for the purpose of securing them together, and therefore must connect them by external fastenings, that is, fastenings secured to the *exterior* of the twins. When practical, scientific ship-builders pronounce such a mode of fastening twins together to be superior to mine, I shall then begin to think I am in error, but the opinion of Archimedes is not a lever of sufficient power to disturb my confidence on that point in the least.

Before I let the barrel of Archimedes off, I feel bound to give it a few more buffets, which its arch-like structure may perhaps enable it to withstand.

Arches, we all know, when sustaining a very severe pressure, especially if it comes against them with a *sudden* and forcible momentum, are intended to receive that pressure *spread equally* over all parts, or else it might, by being concentrated at one or two points, be sufficient to break an arch which it could not even shake were it to bear equally on all points. Recollecting this, we will take Mr. Burden's and my inventions to sea, in a heavy gale, and in endeavoring to escape its fury we both unconsciously steer towards a hard sand bank, upon the ridge of which our boats strike for some time before we can force them over. The sides of this ridge being known to be quite shelving and steep, we thereby ascertain that at every blow or descent in the trough of the sea, a surface of twelve square feet only of the bottoms of our boats is brought in contact with it. Now, sir, here is violent and sudden pressure concentrated to a point with a vengeance, and I think, if you were on board my boat, that you would congratulate yourself that you had gotten a firm stout frame and planking outside of that between yourself and the ridge, instead of the bare staves of Mr. Burden's boat. I doubt not that you could tell without hesitation which boat would be soonest broken through. "So much" for the comparative strength of the two inventions. Archimedes asserts, that by making the inner sides straight I only remove the angle of resistance to the exterior side. I beg you to observe, that he here calls the curve of the inner sides, that is, the "swell," an angle of *resistance*, and yet, by applying this resistance, Mr. F. *increased* the speed of his boat!

I agree with A. that I remove an angle of resistance; but is he not aware that I diminish the *degree* of resistance by that removal? The last paragraph but one before the postscript of my published letter I should think ought to have suggested to him the reason why I diminish the resistance. His not perceiving it satisfies me, that, like his great namesake, he knows better how to set about *destroying* vessels than how they act upon, or are effected by, the water.

But to the point: we will suppose that the water impinges upon the two bows of a vessel sailing at a certain known rate, with a constant force of 1000 lbs., which force, setting aside the inertia resulting from the gravity of the vessel, is the only opposition to her keeping pace with the wind.

Of course, two such vessels, not at all connected, would be impinged upon, sailing at the same rate, with a total force of 2000 lbs. Connect those vessels, so as with them to form a common twin boat, and then, sir, although the two exterior bows would be resisted only by the original force of 1000 lbs. the two inner ones would immediately experience a *greater* opposition, which would be in proportion to the proximity of those inner bows to each other, as well as proportionate to other particulars, such as moving power, angle of the bows, &c. Why? Because the exterior bows could, as when the boats were unconnected, easily dissipate and disperse the impinging water in the shape of a swell, or wave, that would be *left behind* rolling along on either side; but the two inner bows would, as to this dispersion, act in opposition, and would thereby immediately accumulate a head of water, which they would have to *force* along *before* them constantly, and make it keep pace with them at any rate of speed, because more water would make its entrance in any one moment of time between those inner bows than could in the same space of time pass out from between them at the point where they converge towards each other. It must be admitted, of course, that, as connected twins, these two vessels would experience more opposition to their motion than 2000 lbs., the amount experienced when single. By removing the inner bows, or angles, and placing them wholly on the outside, I should have to work against the original amount of resistance 2000 lbs. only.

Mr. Burden's inner as well as exterior bows, or angles of resistance, are so very acute, as to the careless spectator thereof might appear too trifling to create much opposition; but, let that spectator reflect on the degree of opposition which must inevitably result from the motion of a volume of water 21 or 22 feet wide, with a velocity of 12 or 15 miles per hour, through a passage not over 150 feet long, and whose width decreases gradually to its outlet, until it is there only 16 feet.

If dead water, as sailors term it, or back-water, according to Archimedes, would not be created thereby, both at the head and stern, I must confess that I am at sea on this matter without rudder or compass. That a twin boat built on my plan would be superior to one on Mr. Burden's, in point of draft, was, I think, clearly proved in my first letter, and therefore

needs no further argument. Archimedes does not deny it. After having read the foregoing matter, Archimedes must in candor allow—

1st, That I am the inventor of the boat described as mine;

2d, That it is different from Mr. Frirman's;

3d, That it is superior to Mr. Burden's, in the matter of its parts being strongly connected together;

4th, That it has less draft than his; and

5th, That the straight passage in the centre of Mr. Fairman's boat, as *originally* planned, or of mine according to its *unchanged* plan, *is* an advantage over Mr. Burden's boat.

That this communication will operate "for A.'s future benefit, and the benefit of others," is my sincere wish and its object.

Before concluding, I deem it necessary to state, that my letter, as published in the Evening Star, from which I suppose you copied it, was printed very imperfectly; several omissions of single words, and, in one instance, of a *whole line*, having been made, by which the true meaning in some parts is almost wholly obscured. When I learned that it was to be republished by you, I forthwith sent on directions for it to be corrected, but they arrived too late. I am, sir, very respectfully, your obedient servant, CHARLES HARRIS.

Harris' Steamboat. By A KNICKERBOCKER. To the Editor of the Mechanics' Magazine, and Register of Inventions and Improvements.

Sir,—In your last number I saw a description of a twin-boat patented by Mr. Charles Harris, which he appears to value very highly, and thinks that his boat will supersede that of Mr. Burden.

There were also some remarks from "Archimedes," respecting the above invention, and stating that a Mr. Fairman, of Middletown, Ct., had constructed a similar boat in 1817.

I wish to inform Mr. Harris, (as it may probably save him or his friends considerable expense,)—also Archimedes,—that during the late war, Robert Fulton built for the United States' Government the steam-frigate "Fulton the First," and that she was "split into equal parts longitudinally, from stem to stern, down through the keel, and the two halves placed a distance from each other in parallel lines, and joined above water by timbers and decks in the most substantial manner." Previous to or about the same time, I saw a boat built on a similar plan, called the "Happy Couple." Not answering the expectations of the projector, the Couple were cut asunder, the beams shortened, and the two halves fastened together by the keels, stems, &c., and thus made a single boat. She was then used as a sail-boat. I have sailed in her often. Her projector, Mr. I. J., now resides in this city. A KNICKERBOCKER.

New-York, April 7, 1834.

The following communication, disputing the claim of Mr. Burden to be considered as an inventor, appeared in the Quebec Gazette of 2d April, 1834.

To the Editor: Sir,—It is generally the case that those who bring into practical operation any invention in the arts,—if that operation be attended with great public advantages,—the enterprising individual who has been the means of securing them receives the merit of the invention.

The steamboat first practically introduced on the Hudson, by Fulton, had many years before been put in operation near Glasgow, and then Fulton, a native mechanic, assisted the real inventor, and brought with him to America the labor, genius, and experience of his master.

What is now called *Burden's boat* is not new. A boat exactly of a similar construction as to form, and differing in no wise except in the hull, which in the latter is on the principle of a common barrel, has been publicly moving across the Frith of Tay, at Dundee, in Scotland. A simple description given in the London Penny Magazine, for July last, will convince every one that Mr. Burden's invention is, so far as we know, limited to a mere barrel build, (and even this may not be his own, as Annesley's ships, built in Quebec, were at least nearly similar,) which affords lightness and buoyancy, but which is attended with great danger on the boat's striking.

"The common road from Edinburgh to Dundee runs in nearly a straight line from Pettycur through the county of Fife, and across the Frith of Tay, which at Dundee is about two miles in breadth. There is, on this passage, an excellent steamboat of a peculiar construction, the paddles being placed in the middle, as if there were two boats joined, and the form being such that it moves equally well with either end foremost."—[From the Penny Magazine, Monthly Supplement for July, 1833, page 293.]

O. Q.

Experiments made on the Forth and Clyde Canal, to ascertain the best form of Canal Boats. By J. ROBINSON, Esq., Secretary of the Royal Society of Edinburgh. [From the Transactions of the Society of Arts, Second Part for 1833.*]

In the way in which experiments to ascertain the forms of least resistance of floating bodies have generally been made, so costly an apparatus, and so much precision and skill in observation, have been required in order to give any value to the results, that comparatively few persons have been enabled to undertake such investigations, notwithstanding the obvious advantage to be derived by those interested in canal navigation, from an accurate knowledge of the forms most suitable for vessels, according to the circumstances under which they are to be employed.

The great increase of speed which has lately been effected in railway carriage having made

* Mr. Robinson was presented by the Society with their large silver medal for this very valuable communication.

it expedient that corresponding improvements should be introduced into the transport of goods on canals, it became the interest of canal proprietors to use active endeavors for this purpose. The directors of the Forth and Clyde canal have shown themselves particularly well disposed to encourage such investigations, and have applied a considerable portion of their revenue to the construction of experimental steam-vessels, and to the improvement of the facings of the canal, so as to admit of the transit of large vessels at rates of speed which, until lately, have been supposed impracticable in confined water.

In order to obtain a maximum of effect from the power employed in such steam-vessels, it was necessary to ascertain as nearly as possible the form which should be given to their bodies: and as much diversity of opinion existed on this point, I ventured to suggest to the directors that experiments should be made on the canal with models of a sufficient size to admit of safe conclusions being drawn from the results of the trials.

In consequence of this suggestion, four models were prepared, of the following dimensions:

No. 1 was 8 feet 3 inches long, 2 feet wide, and 1 foot deep;

No. 2 was 8 feet 3 inches long, 2 feet wide, and 1 foot 6 inches deep;

No. 3 was 8 feet 3 inches long, 2 feet wide, and 1 foot 6 inches deep;

No. 4 was 9 feet 1 inch each part, 1 foot wide, and 1 foot deep;

And the weight of each 187½ lbs.

No. 1 was quite flat on the floor, rounded at the bilges, and perpendicular in the sides at the midship section, but with a fine entrance and run.

No. 2 was made in the proportions of an ordinary coasting trader.

No. 3 in the proportions of a sharp-built schooner.

No. 4 was a twin boat, similar in its sections to No. 1, only that the breadth of each portion was half of the other breadth, while the depth was the same.

The weight of all the models being alike, their displacement of water was equal, although their draft, or depth of immersion, was necessarily different.

The usual way of trying the resistance of floating bodies is by drawing them across a dock or basin, by a cord running over delicately hung pulleys on a high mast, and with certain weights attached: the time is accurately noted which each form requires to move through a certain space, and the comparative resistances are calculated from these elements. This method presents many difficulties and disadvantages; and I therefore resolved on adopting a different one, which should admit of each experiment being carried on through a much greater space than can be accomplished by means of cords and pulleys. My first intention was to tow each model by a long slender line from the after part of a light steamboat, which was capable of running about seven miles per hour in the canal. This line was to have been attached to an hydrostatic dynamometer, and by this means the strain exerted on the towing line at every different rate of speed by each of the models *in succession* might have been approximated. I was enabled, however, by a suggestion from an ingenious friend (Mr. Oldham, of the Bank of Ireland), to adopt a much more summary and satisfactory way of determining the comparative resistance of the different models; and as it was the *comparative* resistance alone which required investigation, there could be no inducement to go through the more tedious process of trying the resistances separately, and of incurring the risk of error from mistakes in reading off the indications of the dynamometer.

I prepared accordingly a spar or yoke, of 16 feet 8 inches long, which was divided into 100 parts of 2 inches each; a small eye-bolt was fixed at each extremity, and a shifting hasp fitted to the middle part. With this yoke all the experiments were made by the two following processes. 1st, a model was attached by a slender towing-line to each eye-bolt, and the hasp was fixed exactly in the middle of the yoke, and linked to an outrigger on the steam-vessel, which was then set in motion at the required speed. If it was found that one of the models preceded the other, in consequence of its offering less resistance, the hasp was shifted along the spar towards the sluggish one, until the resistances were balanced, and the two models ran abreast of one another. The relative lengths of the arms of the yoke then gave an inverse measure of the comparative resistances of the models, *at that* rate of speed; this being noted down, the hasp was brought again to the middle of the yoke, and the model which showed least resistance was by degrees loaded with weights until it again exactly balanced the other, and swam abreast of it; the amount of the added weights being likewise noted, afforded a second measure of the difference of the resistance of the two models.

Each of these forms of the experiment was gone through with different pairs of the models, and was frequently repeated through long spaces of the canal, as it was found that various circumstances interfered to render the resistances inconstant, such as approaching nearer to the one or the other side of the canal, passing a loaded vessel, or making a turn round a projecting part of the bank.

It was at first attempted to conduct the experiments by towing the models astern; but it was immediately found that the ripple of the wake of the steamer disturbed the uniformity of the resistance of the models. Various modifications were then tried with more satisfactory results, and finally the arrangement was made as follows: A spar, like a bolt-sprit, of about twenty feet in length, was run out a little above the level of the water from the bow of the steamer, the hasp of the yoke being attached by a link to the point of this spar, the models were in this way kept ahead of the steamer in smooth water, and were altogether undisturbed by any ripple or wave.

TABLE A.—Experiments with equal Loads.

Models tried.	*United Weights of Vessel and Load.*	*Divisions in the Arms of Yoke when at 3 miles per hour.*	*Difference.*	*Divisions in the Arms of Yoke when at 6 miles per hour.*	*Difference.*
No. 1. Flat Vessel No. 2. Coaster....	192 each	48 52	4 div. or 1-12	50 50	None.
No. 1. Flat Vessel No. 2. Coaster....	256 "	46 54	8 div. or 1-6	50 50	do.
No. 1. Flat Vessel No. 2. Coaster....	320 "	47 53	6 div. or 1-8	49½ 50½	2-100 parts
No. 1. Flat Vessel No. 2. Coaster....	392 "	45 55	10 div. or* 1-5	49 51	2 div. or 1-24.
No. 1. Flat Vessel No. 3. Schooner..	192 "	45 55	10 div. or* 1-5	50 50	....
No. 1. Flat Vessel No. 3. Schooner..	256 "	43 57	14 div. or 1-3	50 50	....
No. 1. Flat Vessel No. 3. Schooner..	320 "	44 56	12 div. or 1-4	uncertain	
No. 1. Flat Vessel No. 3. Schooner..	392 "	45 55	10 div. or* 1-5	49 51	2 div. or 1-24.
No. 1. Flat Vessel No. 4. Twin do..	256 "	50 50	0 0	uncertain	.... In favour of No. 1
No. 1. Flat Vessel No. 4. Twin do..	320 "	53 47	6 div. or 1-8	uncertain	.... In favour of No. 1
No. 1. Flat Vessel No. 4. Twin do..	392 "	52 48	4 div. or 1-12	uncertain	.... In favour of No. 1

TABLE B.—Experiments with equal Arms of the Yoke at 3 miles per hour.

Models compared.		*Depth of Immersion in inches.*	*Weight of Vessels with their Loads.*	*Difference.*	
No. 1 No. 2	Flat Vessel.. Coaster.....	4·91 8·5	256 lbs. 288 "	32	No. 2 carries 1-8 more than No. 1.
No. 1 No. 2	Flat Vessel.. Coaster.....	6·083 10·083	320 " 392 "	72	No. 2 carries 2-9 more than No. 1.
No. 1 No. 3	Flat Vessel.. Schooner ...	4·17 8·41	192 " 234 "	42	No. 3 carries 2-9 more than No. 1.
No. 1 No. 3	Flat Vessel.. Schooner....	5·75 10·25	320 " 362 "	42	No. 3 carries 2-15 more than No. 1.
No 1 No. 4	Flat Vessel.. Twin Vessel.	4·17 4	256 " 256 "	00	No difference at this rate of speed.

N. B.—The depth of immersion entered above is that observed when the vessels were at rest, and which did not appear to alter when in motion.

TABLE C.—Experiments with equal Arms of the Yoke at 6 miles per hour.

Models Compared.		*Immersion in inches.*	*Weight of Models when loaded.*	*Difference.*
No. 1. No. 2.	Flat Vessel.... Coaster.......	4 2-12 6 4-12	192 lbs. 192 "	—
No. 1. No. 2.	Flat Vessel.... Coaster.......	4 11-12 8 1-12	256 " 256 "	—
No. 1. No. 3.	Flat Vessel.... Schooner shape	4 7-12 7 9-12	192 " 192 "	—
No. 1. No. 3.	Flat Vessel.... Schooner shape	4 11-12 9 2-12	256 " 256 "	—
No. 1. No. 4.	Flat Vessel.... Twin Boat....	5 9-12 5 7-12	320 " 320 "	—

The draught of water noted in the column of immersions was that observed when the models were at rest previous to the commencement of each experiment; the actual immersion during the experiment was considerably less, especially in the flatter vessels; but there were no means of ascertaining it precisely.

The accompanying tables contain the results of these trials, from which the important inference may be drawn, that there is no form which will present a minimum resistance in all circumstances; and that the form which is easiest drawn through a canal at a low velocity does not possess the same advantages at a higher rate of speed.

By looking into the table A, experiment 1st, we see that, although the resistance of No. 1 be to that of No. 2 as 13 to 12, when the velocity is 3 miles per hour, yet when the speed is increased to 6 miles, the advantage which No. 2 had over the flatter vessel entirely disappears.

Again, in table B, we see that in one experiment No. 2 carries two-ninths more weight than No. 1, with equal resistance, when the velocity is 3 miles per hour; but that when the rate is raised to 6 miles, the loads require to be made the same in both, in order to equalise the resistance.

It appears, from numerous experiments made at intermediate speeds, that this change in the relative resistance is progressive; there is reason, therefore, to conclude, that if circumstances had admitted of carrying on the experiments at a higher velocity than 6 miles per hour, the flatter formed vessel would have attained a superiority over the sharper ones: this conclusion is corroborated by the fact, that the swiftest going steam-vessels which have been built in this country are those which are nearly quite flat in the floor for a great proportion of their whole length.

The first practical inference which may be drawn from these experiments is, that all vessels which are intended to be tracked, or impelled by machinery, through canals at low velocities, should be built as sharp in their bottoms as circumstances will admit of, although this must necessarily increase their draught of water; the second inference is, that whenever vessels are intended to move in canals with a higher rate of speed than 6 miles per hour, the general form of the bottom should be nearly quite flat.

Important Discovery.—We learn that Mr. George B. Moores, of this village, has invented a process for the application of steam power, so that boats, carriages, &c. may be propelled with the same velocity they now are, with one-fifth of the fuel which is now used for that purpose. From the representations of several scientific gentlemen who have investigated the subject, we feel warranted in predicting that Mr. Moore's discovery will prove as beneficial to the world as was the original invention of steam-engines.—[Union Village Banner.]

Specification of a Patent for Furnaces for Generating Heat by Friction, and applying the same to economical purposes. Granted to John W. Cochran, *Lowell, Middlesex county, Massachusetts, November* 19, 1834.

To all whom it may concern, be it known, that I, John W. Cochran, of Lowell, in the county of Middlesex, and state of Massachusetts, have invented a *Friction Furnace* for generating heat without the consumption of fuel, and applying the same to economical purposes; and I do hereby declare that the following is a full and exact description of my said invention.

Although the fact that heat may be generated by friction is one of universal notoriety, it does not appear that the idea of applying this heat to economical purposes has ever been practically acted upon; I, however, have ascertained by satisfactory experiments that it may be done to great advantage. The most convenient way of effecting the object is to prepare two metallic disks, or cylinders, say of cast iron, in the form of common mill stones, and to cause one of them to revolve against the other, under considerable pressure, which pressure may be given by the weight of one of the disks, or by that of a vessel containing water, or other fluid, to be heated, the bottom of which may take the place of one of the disks; or by weighted levers, or in any other way of producing pressure which may be preferred. When I make two disks of this description to rub against each other, I form one or both of them somewhat hollow towards the centre, on the touching sides, as a bearing on that part would tend to diminish the friction towards the periphery, where the motion is the most rapid.

There are many ways in which I contemplate the application of this principle, as, for example, I intend sometimes to cause two disks, such as I have described, to revolve one against the other, by power derived from a water wheel, or from any other convenient source, and to enclose them within a drum, or chamber, into which a current of cold air shall be admitted, and whence it shall be conducted by suitable tubes, after it has been heated by being brought in contact with the disks; thus using it to warm the apartments of any building, or for other purposes. Where steam is preferred, I intend sometimes to allow water to fall in a small stream upon the heated disks, and to conduct it thence through tubes to wherever it may be required. Where steam is to be generated to drive machinery, the bottom of the boiler may be made of suitable form, and to bear upon a disk revolving below it; or the bottom may be perforated, to allow the shaft of a disk revolving in the inside thereof to pass through, and to be turned by any suitable apparatus, by power derived from the steam generated by the heat from the friction, or from any other source.

These various modes will sufficiently illustrate the principle upon which I depend for rendering the heat which was latent, sensible, and active; but I do not intend by this enunciation to restrict or confine myself to the form of apparatus herein described, or to the objects to which it may be applied, but to vary the same in any manner which I may find most convenient and efficient.

It may at first appear that the powerful friction necessary to engender sufficient heat to be usefully employed as a substitute for that extri

cated in the combustion of fuel, will produce a rapid wearing out and destruction of the rubbing apparatus; I, however, have ascertained, satisfactorily, that when the metals become heated, there is a degree of repulsion produced between them which admits of but little abrasion of their substance.

What I claim as my invention, and for which I ask a patent, is the application of the heat generated by the friction of pieces of metal against each other, to the purpose of heating air, generating steam, and, in fine, to all the economical purposes to which such heat is applicable, proceeding, in its production, upon the principles herein before set forth. John W. Cochran.

Observations on Flame—Mr. Rutter's Late Discovery. [From the London Mechanics' Magazine.]

Sir,—There is something very pleasing in applying chemical knowledge to the explanation of the various phenomena that are daily before our eyes. I now propose, with your permission, to make a few observations on the flame of a candle that is now burning on my table. I shall observe, at first, that the heat of the flame melts the tallow, which then ascends the wick by capillary attraction, and is in consequence subjected to intense heat; the tallow is next decomposed, and the principal part of the resulting gas is carburetted hydrogen, which is again decomposed in the following manner: When this gas is first formed, it expands in every direction, and thus getting into the hottest part of the flame, its carbon is deposited in an abundance of fine particles; the hydrogen now increases in volume three and a half times the bulk it possessed when in perfect chemical union with the carbon. This expansion, which is probably again more than doubled by the intense heat of the flame, causes the hydrogen to appear at the outer surface of the flame, where it unites with the oxygen of the atmosphere, and envelopes the white and luminous flame, or that part containing the particles of carbon, with a thin sheet of blue flame.

I now come to a very difficult part of this subject, which, I think, will, when satisfactorily explained, have a great tendency to illustrate Mr. Rutter's discovery of the advantage of burning water with coal-tar, which is by far the greater part carbon; *the difficulty is, to account for the appearance of oxygen in the interior of the flame.* Lord Bacon proved that flame would burn within the interior of flame; and Dr. Ure, in his *Dictionary of Chemistry*, relates a similar experiment, and gives the following definition of flame, founded on the researches of Sir H. Davy: "The flame of combustible bodies may, in all cases, be considered as the combustion of an *explosive mixture* of inflammable gas, or vapor, with air." It may seem very presumptuous in me to differ with such authorities as Davy and Ure, but my defence is, that I regard truth more than all the authorities in the world. I question the truth of the above definition of flame on this ground, that the flames of "*explosive mixtures*" give no light, but afford merely a feeble blue flame. This is the case with explosive mixtures of coal-gas, oil-gas, and indeed all gases containing carburetted hydrogen or olefiant gas; surely, then, the flame of a candle, or of olefiant gas from a small aperture, exhibits phenomena very different from the combustion of an explosive mixture. After giving the aforementioned definition, Dr. Ure says, alluding to flame: "It cannot be regarded as mere combustion at the surface of contact of the inflammable matter. This fact is proved by holding a taper or a piece of burning phosphorus within a large flame made by the combustion of alcohol. The flame of the taper or phosphorus will appear in the centre of the other flame, proving that there is oxygen even in its interior part." This is, in my opinion, no proof whatever of oxygen being in the interior part. There may be carbonic acid, or there may be vapor of water, &c.; and what confirms this conjecture, is the well known fact that carbon can decompose carbonic acid, or at least unite with one atom of its oxygen, thus forming carbonic oxide; for carbonic acid is composed of one atom of carbon and two atoms of oxygen. Carbonic oxide may therefore decompose the vapor of water formed by the union of the hydrogen with the oxygen of the atmosphere, or carbon itself may decompose the vapor of water; this latter is my opinion. But, it may be asked, how does the vapor of water find its way into the interior of flame? In the case of the candle-flame, I apprehend, it is by the union of the hydrogen with the oxygen of the atmosphere at the surface of the flame; and I have before explained that the expansion of the hydrogen, when the carbon is deposited, is the cause of its being projected with considerable velocity to the outer surface of the flame. When the hydrogen thus unites with the oxygen, water is formed, which being immediately subjected to extreme heat, expands with great velocity into vapor, which is projected, not only into the interior of the flame, but from the sides where it is formed. The carbon decomposes this vapor, and, by uniting with its oxygen, hydrogen is again formed, which may be repelled by the sudden expansion which it must have when the carbon seizes the oxygen, to the exterior of the flame, where, uniting with oxygen, it may again return to the interior—and thus play backward and forward many hundred times in a second. This play of affinities would, however, soon cease, were not the supply of hydrogen kept up by the continual and *first* decomposition of the carburetted hydrogen. That vapor is projected from flame is proved when I hold the point of a pair of *cold* steel snuffers within, say three-eighths of an inch of the flame, by moisture being deposited; but the particles are so fine, and in so small quantity, that a dull appearance only of the steel results, which quickly vanishes on their removal. Should the snuffers be held very near the flame,

small drops of water will appear on their removal. As this deposition of moisture takes place when the snuffers are held under the flame, and at a distance of perhaps one-fourth of an inch, I conclude it to be projected with considerable velocity, in the manner before pointed out, from every part of the flame; and I further consider that this atmosphere of vapor may, in some measure, account for the luminous halo which appears to surround the flame of a candle.

There are many other considerations which induce me to believe the above conjectures to be nearly right. One is, that if carburetted hydrogen be mixed with a very small portion of common air, its power of giving light is impaired, for part of the carbon is then burnt in its gaseous combination. Another circumstance that induces me to question the presence of oxygen in the interior of the flame of carburetted hydrogen, is the fact, that a small portion of carbon, when deposited on a small fibre of the wick of a candle, will remain in the white part of the flame without undergoing decomposition. Now, if oxygen were present in an uncombined state, and at such an elevated temperature, who can doubt that an immediate decomposition of the carbon would take place? But, it may be asked, why does not this portion of carbon decompose the vapor of water which you consider to be present in all flames containing hydrogen? One cause may be that the particles of which it is composed attract each other with part of their force, and cannot therefore exert their full force to decompose the vapor. That coal-tar cannot be burned like oil is because it is nearly all carbon, and has not sufficient hydrogen to form the requisite quantity of vapor—what it does possess being only sufficient to supply part of its carbon with oxygen; the other part of the carbon deposited rises from the flame in dense black smoke. It may be further inquired, why does not the black smoke, or the carbonaceous particles arising from a hot flame, unite with the oxygen of the atmosphere, and so form carbonic acid, which is invisible? I apprehend it is because of their low capacity for heat, and the instantaneous radiation of heat from their surfaces; the particles being thus deprived of their heat cannot unite with oxygen, which is also cold—for the union of carbon with oxygen will not take place under a dull red heat. Is it possible, then, to burn coal-tar without producing smoke? Nothing is more easy to a person possessing a slight knowledge of chemistry: let a long tunnel of fire-brick be constructed, leading to a chimney, and let a coal fire be lighted till the sides of this tunnel become of a white heat; if a small stream of coal-tar be now introduced, it will inflame, and as the particles of carbon deposited cannot lose their heat, and will be floating in a strata of air heated to redness, their union with oxygen must take place, provided sufficient air be admitted with the stream of coal-tar.

I shall now conclude with a few words on Mr. Rutter's project of introducing a small quantity of water with the tar. The water will first be formed into vapor, which will require some portion of heat; now this vapor may be decomposed by the carbon, when the hydrogen will again unite with the oxygen of the atmosphere, and vapor will again be formed, till the decomposition of all the carbon is complete. Perhaps two gallons of water is more than one gallon of coal-tar could be made to decompose, and it would be very gratifying to me to see the actual fact proved by experiments so conclusive as to satisfy the doubts of the most sceptical. Your Salisbury correspondent states, that "15 lbs. of coal-tar," which I suppose is about equal to an imperial gallon, "and an equal bulk of water," say 10 lbs, "and 25 lbs. of Newcastle coke, will be found equal to 120 lbs. of Newcastle coal." But this is on the supposition that the whole of the water will be decomposed, which I consider a practical impossibility, for a large portion of the carbon must unite with the oxygen admitted to inflame the hydrogen.

Should Mr. Rutter, however, have formed too high an estimate of the heat gained by his process, there are other advantages attending it which must not be overlooked; for two intense chemical actions are supported with the same volume of air that either of them would require separately, which is of great importance in its application to steam boilers. Your Salisbury correspondent has certainly blundered in endeavoring to explain this. (See his paragraph, page 452, beginning with "Another condition," and ending with "gases.") He is also wrong in saying, (page 453,) "The sides of the furnace in that vessel formed a part of the boiler, consequently their temperature never exceeds that of the contained water." How then is the heat communicated, if both sides are of the same temperature? According to my experience, the sides of boilers are often many hundred degrees hotter than the contained water, and sometimes red hot just at the outer surface.

I have no other object in making these remarks than to elicit truth, and prevent scientific men from trusting too much to "hope's delusive mine." I remain, sir, your obedient servant,

William Witty, Jun.

Neither Lighting nor Heating by Gas of Modern Origin.*—In several situations removed from any volcanic action, so far as is visible on the surface, natural jets of inflammable gases are seen to issue, affording decisive evidence of chemical changes that are taking place at various depths beneath. Of these, some have served the purpose of the priest to delude mankind, while part of the others have been more usefully employed.

Carburetted hydrogen gas is well known to be the "fire-damp" of the coal districts, and to

* From Mr. De la Beche's Geological Manual (third edition, considerably enlarged in 1833), one of the most instructive and entertaining works which the new and important science of geology has yet produced.—Ed. M. M.

issue from the coal strata; collecting in the ill-ventilated galleries of collieries, and, when sufficiently mixed with atmospheric air, exploding with great violence when approached incautiously with an unprotected flame, spreading mourning and misery among the families of the miners. If the genius of Davy had merely produced his safety lamp, it would alone have united him to the applause and thanks of mankind.

As carburetted hydrogen is so freely liberated in coal mines, it would be expected that it should occasionally be detected on the surface, and accordingly it has been so discovered.* Inflammable gas also occurs in other situations, where there is no reason to suspect the presence of coal strata. Of this the well-known jets of gas in the limestone and serpentine district of the Pietra Mala, between Bologna and Florence, afford an example.

Captain Beaufort describes an ignited jet of inflammable gas, named the Yanar, near Deliktash, on the coast of Karamania, which perhaps once figured in some religious rites. He states that, "in the inner corner of a ruined building, the wall is undermined so as to leave an aperture of about three feet in diameter, and shaped like the mouth of an oven; from hence the flame issues, giving out an intense heat, yet producing no smoke on the wall." Though the wall was scarcely discolored, small lumps of caked soot were formed in the neck of the opening. The hill is composed of crumbly serpentine and loose blocks of limestone. A short distance down the hill there is another aperture, which, from its appearance, seems once to have given out a similar discharge of gas. The Yanar is supposed to be very ancient, and is possibly the jet described by Pliny.

Colonel Rooke informed Captain Beaufort, that high upon the western mountain at Samos there was an intermittent flame of the same kind; and Major Rennel stated, that a natural jet of inflammable gas, inclosed in a temple at Chittagong, in Bengal, is made use of by the priests, *who even cooked with it.*

According to M. Imbert, gaseous exhalations are employed at Thsee-Lieon-Tsing, in China, to distil saline water, obtained from wells in the neighborhood. Bamboo pipes carry the gas from the spring to the place where it is to be consumed. These tubes are terminated by a tube of pipe clay, to prevent their being burnt. A single well (of gas) heats more than three hundred kettles. The fire thus produced is exceedingly brisk, and the caldrons are rendered useless in a few months. Other bamboos conduct the gas intended for lighting the streets and great rooms or kitchens.

M. Klaproth notices other jets of inflammable gas in China; one, now extinguished, is stated to have burnt from the second to the thirteenth century of our era.

It also appears that M. Rœders, inspector of the salt mines of Gottesgabe, at Reine, in the country of Tecklenberg, has for two or three years used an inflammable gas, which issues from these mines not only as a light, but for all the purposes of cookery. He obtains it from the pits that have been abandoned, and conveys it by pipes to his house. From one pit alone a continuous stream of this gas has issued for sixty years. It is supposed to consist of carburetted hydrogen and olefiant gas.

Inflammable gases are also found to proceed from ground charged with petroleum and naphtha. The inhabitants of Baku, a port on the Caspian Sea, are supplied with no other fuel than that derived from the petroleum and naphtha, with which the earth in the neighborhood is strongly impregnated. About ten miles to the north-east of this town there are many old temples of Guebres, in each of which there is a jet of inflammable gas rising from apertures in the earth. The flame is pale and clear, and smells strongly of sulphur. Another and a larger jet issues from the side of a hill. If, in the circumference of two miles, holes be made in the earth, gas immediately issues, and inflames when a torch is applied. The inhabitants place hollow canes into the ground, to convey the gas upwards, when it is employed for the purposes of cookery, as well as for light.

The Liverpool and Manchester Railway. [From the London Mechanics' Magazine.]

We have been favored with a copy of the report made by the Directors of this Company, and find in it so much matter of fact that is of universal interest, on the subject of railways and locomotive power, that we need offer no apology for transferring it (with but little abridgment) to our pages. Mr. Grahame, and the other partisans of canal navigation, who still persist, with so much honesty and candor, in representing that the profits of this railway arise mainly from the conveyance of passengers, and that it cannot possibly compete with canals in the conveyance of goods, will observe in this report some rather stubborn facts on both these heads. The common-road steam-carriage charlatans too, who tell us that the expense of working a steam-carriage on a granite highway will be not more than *sixpence per mile*, and the tear and wear *next to nothing* (for "1,700 miles" at least), may learn from the circumstantial details here given of the actual expense of working such carriages on a railway, where the friction is many times less than on the best granite road that can be constructed, how much occasion they have to blush for the delusive representations they have sent forth to the public. We do not of course include in this class of public deceivers any of those honest and intelligent individuals—the Heatons, Hancocks, and Saxulas, of the day—who frankly subscribing to the undeniable fact, that there is more friction to be overcome on a common road than on a railway, have proposed to themselves to determine by experiment whether it would not be cheaper to work steam carriages against that greater friction, than to

* It appears very remarkable, that in the coal districts of the British isles, where such a large amount of carburetted hydrogen is annually produced, means have not been adopted for making an economical use of this gas, both as it respects light and heat.

be at the expense of laying down railways to avoid it—in some cases at least, if not in all. These last are adventurers of a very different stamp; they speculate on a particular result, which, though as yet unascertained, is neither impossible nor improbable; and as long as they pursue the reasonable object they have in view by honorable means, they shall command as they deserve our best encouragement and support.

LIVERPOOL AND MANCHESTER RAILWAY—FOURTH HALF-YEARLY MEETING.

LIVERPOOL, January 23, 1833.

Report.—The Directors, in submitting to the Proprietors a statement of their accounts and proceedings for the half-year ending 31st December, 1833, have to report a considerable increase in the general business of the concern, as compared with the corresponding six months of the previous year.

The total quantity of merchandise conveyed in the six months between Liverpool and Manchester was	69,806 tons.
To and from different parts of the line, including Warrington and Wigan	9,733 "
Between Liverpool and Manchester and Bolton	18,708 "
Total quantity conveyed	98,247 "
Quantity of coal from various parts to Liverpool	32,304 "
Ditto to Manchester	7,830 "
Total to Liverpool and Manchester	40,134 "
The number of passengers booked at the Company's offices	215,071
The number of trips of 30 miles performed by the locomotive engines with passengers was	3,253
Ditto with merchandise	2,587
Total	5,840

Compared with the corresponding six months of the last year, the increase in merchandise conveyed has been 11,405 tons—in passengers, 32,248.

The present winter has been in an extraordinary degree stormy and wet, which has no doubt diminished the amount of travelling.

The wetness of the season also has prevented the railway from being maintained in that complete order which is desirable; while the boisterous weather, with the dirty state of the rails, has impeded the passage of the trains, not unfrequently rendering assistant engines necessary to ensure their progress, even on the level parts of the way. These circumstances have unavoidably increased the charge for locomotive power. On the other hand, the navigation of the river, owing to the long continuance of tempestuous weather, being frequently dangerous, and sometimes impracticable, the utility and importance of the railway conveyance have become more manifest and striking, and the natural consequence has been an accession of traffic to the Company proportioned to the required accommodation afforded to the public.

The following is a statement of the receipts and expenditures for the half-year; and the subjoined table exhibits a detailed classification of the disbursements.

Half-year ending 31st December, 1833.

RECEIPTS.

	£	s.	d.
Coaching department	£54,685	6	11
Merchandise do.	39,957	16	8
Coal do.	2,591	6	6
	£97,234	10	1

EXPENSES.

	£	s.	d.
Advertising Account	£6	10	0
Bad debt do.	374	10	1
Coach disbursement do., viz., guards and porters' wages, 1,168*l.* 4*s.* 6*d.*; parcel carts, horsekeep and drivers' wages, 361*l.* 1*s.* 7*d.*; materials for repairs, 689*l.* 12*s.* 6*d.*; men's wages repairing, 1,041*l.* 1*s.* 3*d.*; gas, oil, tallow, cordage, &c., 196*l.* 4*s.* 11*d.*; duty on passengers, 3,224*l.* 11*s.* 11*d.*; stationary and petty expenses, 277*l.* 4*s.* 5*d.*; taxes on offices, stations, &c., 116*l.* 0*s.* 8*d.*; guards' clothes, 64*l.* 15*s.*	7,138	16	9
Carrying disbursement account, viz., agents and clerks' salaries, 1,728*l.* 16*s.* 9*d.*; porters and brakesmen's wages, horsekeep, &c. 5,006*l.* 6*s.* 10*d.*; gas, oil, tallow, cordage, &c., 529*l.* 17*s.*; repairs to jiggers, trucks, stations, &c., 366*l.* 9*s.* 11*d.*; stationary and petty expenses, 429*l.* 5*s.* 1*d.*; taxes and insurances on offices, &c., 456*l.* 17*s.* 7*d.*; sacks for grain, 110*l.* 3*s.* 10*d.*	8,627	17	0
Coal disbursement account	82	0	9
Cartage (Manchester) do.	3,173	18	0
Charge for direction do.	312	18	0
Compensation (coaching) do.	142	4	8
do. (carrying) do.	223	10	11
Coach office establishment do. viz., agents and clerks' salaries, 302*l.* 6*s.* 8*d.*; rent, 30*l.*	632	6	8
Engineering department account	319	3	4
Interest do.	5,140	6	4
Locomotive power do. viz., coke and carting, 3,197*l.* 4*s.* 4*d.*; wages to coke fillers and waterers, 348*l.* 8*s.* 5*d.*; gas, oil, tallow, hemp, cordage, &c. 865*l.* 14*s.* 9*d.*; brass and copper, iron, timber, &c. for repairs, 3,755*l.* 3*s.* 7*d.*; men's wages repairing, 4,401*l.* 4*s.* 10*d.*; engine and firemen's wages, 784*l.* 8*s.* 5*d.*; out-door repairs to engines, 613*l.* 3*s.* 9*d.*	13,965	8	1
Maintenance of way account, viz., wages to plate layers, joiners, &c., 2,937*l.* 19*s.* 2*d.*; stone, blocks, sleepers, keys, chairs, &c., 2,411*l.* 2*s.* 4*d.*; ballasting and draining, 925*l.* 16*s.* 11*d.*; new rails, 150*l.* 16*s.* 3*d.*	6,425	14	8
Office establishment account, viz., salaries, 607*l.* 2*s.*; rent and taxes, 75*l.* 14*s.* 3*d.*; stationary and printing, 22*l.* 7*s.* 8*d*; stamps, 17*l.* 2*s.* 3*d.*	722	6	2
Police account	1,022	7	6
Petty disbursement do.	61	19	6
Rent do.	602	10	8
Repairs to walls and fences	665	3	4
Stationary engine and tunnel disbursement account, viz., coal, 302*l.* 6*s.* 5*d.*; engine and brakesmen's wages, 319*l.* 11*s.* 2*d.*; repairs, gas, oil, tallow, &c., 419*l.* 15*s.* 5*d.*; new rope for tunnel, 266*l.* 3*s.* 6*d.*	1,309	16	6
Tax and rate account	3,409	11	0
Waggon disbursement do., viz., smiths and joiners' wages, 718*l.* 19*s.* 7*d.*; iron timber, castings, &c., 700*l.* 9*s.* 1*d*; cordage, paint, &c., 28*l.* 5*s.* 2*d.*; canvass for sheets, 163*l.* 6*s.* 5*d.*	1,611	0	3
Cartage (Liverpool)	80	17	10
Law disbursement	390	3	0
	£56,350	1	9

RECAPITULATION.

	£	s.	d.
Receipts	£97,234	10	1
Expenses	56,350	1	9
Net profits for six months	£40,884	8	4

1st July to 31st December, 1833.

DISBURSEMENTS APPORTIONED UNDER THE DIFFERENT HEADS OF EXPENDITURE.

	Per Passenger Booked.	Per Ton of Merchandise Liverpool and Manchester.	Per Ton of Coal.	Per Ton on Bolton Tonnage.	Coaching Department.	Merchandise Department.	Coal Department.	Bolton Tonnage.	Totals.
	s. d.	s. d.	s. d.	s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Disbursements in the merchandise department, consisting of porterage, salaries, parish rates, and insurance, £456 17s. 7d., carting, stationary engine, &c. disbursements	......	3 9¾	......	0 3¼	....	15,150 9 11	....	249 0 8	15,399 10 7
Disbursements in the coaching department, comprising porterage, salaries, repairs, duty on passengers, £3,224 11s. 11d., &c. &c.	0 9	....	......	......	7,913 8 1	....	....	....	7,913 8 1
Porterage, &c. in the coal department, after deducting amount received for weighing coal	.....	....	0 0½	......	....	....	82 0 9	....	82 0 9½
Locomotive power account, proportioned according to the number of trips of 30 miles in each department, comprising repairs of engines, wages, coke, &c. &c.	0 8¾	1 ½	......	......	7,779 0 1	6,186 8 0	....	....	13,965 8 1
Sundry disbursements, proportioned according to the receipts as between the coaching and merchandise departments, and according to the number of tons and miles conveyed, as between the Liverpool and Manchester and Bolton trade, comprising maintenance of way, police, and gate establishment, general office establishment, &c. &c.	0 6¼	0 10½	0 1½	0 7	5,532 0 2	3,494 5 1	262 2 10	547 18 2	9,836 6 2
Rates and taxes, interest on loans, and chief rents, proportioned according to the amount of profit in each department, calculated *exclusively* of these items of disbursement	0 6¾	0 7¾	0 2½	0 1¼	6,190 19 11	2,526 6 3	411 1 5	95 0 5	9,153 8 0
Total disbursements	2 6¾	6 10½	0 4¼	0 11¼	27,345 8 3	27,357 9 3	755 5 0	891 19 3	56,350 1 9
Net profit	2 6½	2 10	0 11	0 5¼	27,339 18 8	11,283 19 7	1,836 1 6	424 8 7	40,884 8 4
Gross receipts	5 1¼	9 8½	1 3½	1 4¾	54,685 6 11	38,641 8 10	2,591 6 6	1,316 7 10	97,234 10 1

Statement of Receipts and Expenditures on Capital Account, from the commencement of the undertaking to 31st December, 1833.

TREASURER, DR.

To amount of joint capital in shares and loans	£1,086,885	0	0
.. Ditto of dividends not paid	1,087	3	1
.. Surplus in hand after payment of the sixth dividend, in August, 1833	395	10	2
.. Net profits of the concern for the half year ending 31st December, 1833	40,884	8	4
	£1,129,252	1	7

TREASURER, CR.

By amount of expenditure on the construction of the way and the works, including the tunnel, excavations, &c. now in progress	1,089,818	17	7
.. Ditto in the hands of Moss & Co., bankers	28,476	11	9
.. Ditto in the hands of the treasurer	242	15	9
.. Ditto of arrears on calls	25	3	6
.. Ditto balance of book debts due to the company	10,688	12	0
	£1,129,252	1	7

During the past six months the excavation of the new tunnel from the vicinity of Waver-street lane to Lime-street has proceeded regularly and satisfactorily, and is now more than half completed.

In order to extend the advantages of a railway conveyance to the northern docks, and those parts of the town which are at a considerable distance from the railway station, the Directors transmitted a memorial to the Common Council, the Dock Committee, and the Commissioners of Sewers, proposing to construct, at the expense of the Company, a line of railway from Wapping to the Clarence Dock, by means of which merchandise deposited at the north end of the port might possess the same facilities of conveyance by railway into the interior of the country as goods in the southern portion of the town, besides relieving tne streets from the noise and interruption of numerous waterside carts. This memorial, as might be expected, from the evident utility of the scheme, has been favorably received, especially by the Dock Committee, and the Commissioners of Sewers; the principal objection to the plan being that it was not sufficiently general and extensive to afford to the public at large that measure of accommodation which appeared so easily practicable. The Directors, however, confidently look forward to the establishment on a comprehensive plan, probably to be undertaken by the Dock Trustees, of a line of railway, with the requisite branches, along the dock quays from the northern to the southern extremities of the port; which mea-

sure seems alone wanting to give to the mercantile public those advantages of economy and despatch which a railway conveyance is so peculiarly calculated to afford.

The proprietors are aware that the subject of locomotive engines has always been one of great interest and importance. The charge under this head continues very heavy, arising in a great measure from the necessity of renewing and strengthening the frame work of the machinery; and from the purchase of copper and brass plates for the renewal of fire boxes and tubes.

The charge for coke has been a heavy item in the locomotive expenditure, amounting to nearly £6,000 per annum. The directors have lately been induced to try gas coke to a very considerable extent. The cost per ton is less than one-half the cost of Worsley coke; and although a greater weight is required to do the same service, and an extra consumption of fire bars and some other difficulties attend the use of it, the Directors have considered the experiment well worth making, in the hope of diminishing the expenditure in that department.

Several new schemes for an improved locomotive power have lately been brought under the consideration of the Directors. Past experience forbids any very sanguine anticipations of success in respect of untried speculations; at the same time, the Directors will not fail impartially to investigate the pretensions of any scheme from a respectable source, which professes to introduce improvement into so important a branch of the Company's establishment.

The charge for the maintenance of the way is another heavy item of the current expenditure. In particular parts of the road, especially on the descending lines of the inclined planes, the rails prove too weak for the heavy engines, and the great speed at which they are moved; and from the breakages which have taken place, the Directors have thought it expedient to order a supply of stronger and heavier rails, to put down in those districts where the present rails have been found insufficient. This proceeding will in the first instance subject the Company to some increased expenditure. The Directors, however, have contracted (for the ensuing year) for that portion of the maintenance of way which consists of labor and small materials on terms of comparative advantage to the Company, which they expect will balance the increased outlay required for the purchase of stronger rails.

The Iron Steamboat Alburkha.—This vessel is now in the river Niger, with the Quorra steamboat, and seems to have been the favorite of the two vessels since they departed on their interesting expedition. The advantages of iron vessels in warm climates are ably pointed out in a short extract we gave in our last number from Chambers' Journal; and these advantages seem in no wise exaggerated in the instance of the Alburkha, according to reports received from those embarked in her. This vessel was built by Mr. Laird, of Liverpool, for the purpose of navigating the shoal water of the river, and we understand that he has since constructed another for the interior navigation of Ireland. We have no doubt that these vessels, from their vast superiority over those of wood, and their durable quality, will speedily be numerously employed.—[Nautical Magazine.]

Burden's Boat.—The "London Mecnanics' Magazine" having copied our engravings of this boat, and also partially the description, from one number of the Railroad Journal, remarks that, comparing the perspective view with fig. 3, "it cannot be a very correct representation of the actual appearance of the vessel; the two trunks do not project so absolutely apart, like two horns, as here shown." If the editor of that work will peruse the description given in this Magazine, he will find that the guard intended to be outside was not there when the trial was made, and that it has been pronounced correct in every particular by the inventor. As a further proof of its correctness, it has been copied in at least 12 periodicals in this country as an authentic account. The editor also states that the boat was built at New-York. He is in error in so asserting: it was constructed at Troy, so far as it appears represented in those engragings. It is now at the Dry Dock in this city, being finished; and we intend, with the assistance of Mr. Burden, and other eminent engineers, to give a full representation of it very soon, with such explanations and references as are necessary; and, on its first trip, to record every particular of interest to our readers.

Salt.—The people of Onondaga county, N. Y., believe that they have under them an inexhaustible mass of rock salt, and that in raising this, instead of brine, they shall save half the expense of manufacturing, and be able to supply the Atlantic towns with salt cheaper than they can import it. There is one difficulty which now threatens, and that is the expense of fuel. The wood now used at the different salt springs now in operation amounts to 400 cords a day, and as the works are in use 200 days in a year, the annual consumption is 80,000 cords.

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 25 cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*.—John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

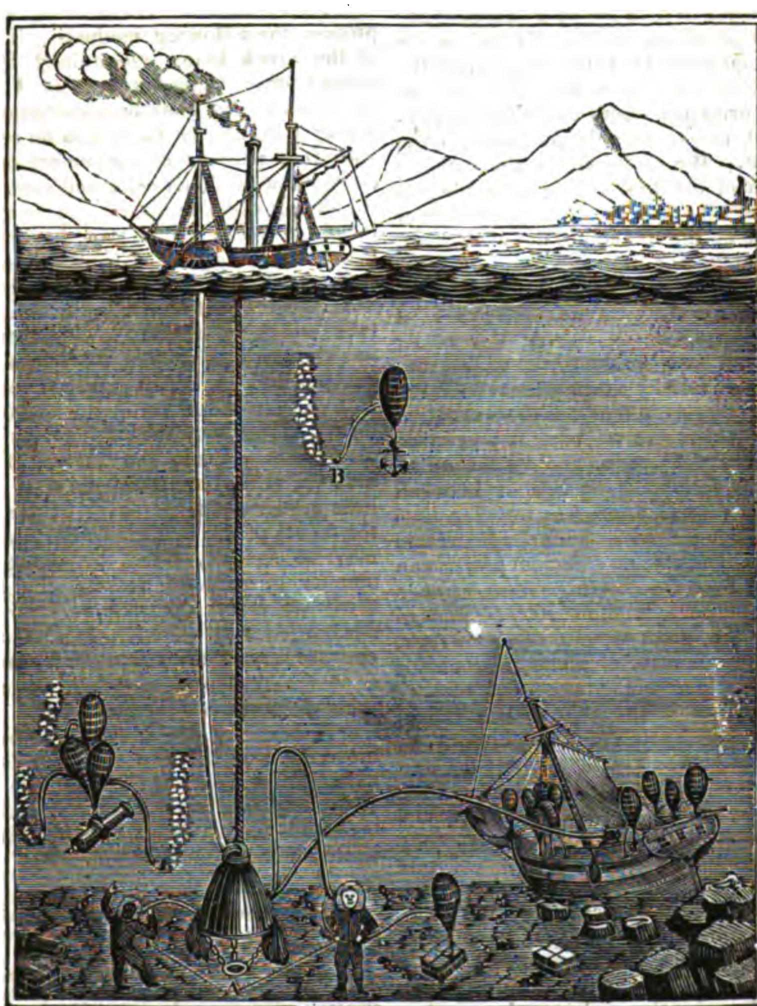
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] MAY, 1834. [NUMBER 5.

Do not think learning in general is arrived at perfection, or that the knowledge of any particular subject in any science cannot be improved, merely because it has lain five hundred or a thousand years without improvement.—WATTS ON THE MIND.



Plan for raising Vessels sunk in Deep Water. By Mr. JOHN MILNE, Teacher of Architectural and Mechanical Drawing, Edinburgh. [From the London Mechanics' Magazine.]

SIR,—Having read in a recent number of your Magazine, that Dr. Hancock has proposed the use of *air* as a power for raising goods, &c. from the bottom of the sea, I beg to forward to you a pamphlet of mine published in 1828, which contains, among other plans, two on this very principle. They attracted some share of attention at the time of publication, but neither of them has ever,

as far as I am aware, been carried into actual practice. Should you see cause, I shall be glad to find that you have drawn the attention of the public to this important but neglected subject. I am, respectfully, your obedient servant, JOHN MILNE.

The pamphlet obligingly forwarded to us by Mr. Milne,* is entitled "Plans for the Floating Off of Stranded Vessels; and for raising those that have foundered; with an Improved Method of Carrying Vessels over Banks in Shallow Water." Of the two plans to which Mr. Milne more particularly invites our attention, one is adapted to the case of ships sunk near the shore, and the other to deep sea operations. Both are on the same principle—both exceedingly ingenious, and, in our humble judgment, quite practicable. We shall extract the author's description of the first at length, and beg to refer those who may be desirous of further information on the subject, to the work itself, which is altogether well deserving of perusal.

"I shall now describe the application of these air buoys,† to the raising of a vessel that has been sunk in deep water; but before doing so, it may be proper to mention the disadvantages attending the common practice. At present we pass one or more chains round the wreck, and by means of these chains suspend it by one, or between two floating vessels, a process which in deep water is attended with much expense and uncertainty, because no sufficient power can be applied from the floating vessel to raise the wreck at once to the surface. Moreover, from the great weight of the wreck, and from the manner of placing the chains about it, they are liable to cut the timbers of the ship, as in the case of the Comet steam-boat (see Narrative of the Loss of the Comet steamboat). The operators must wait till the lowest ebb of the tide, then, pulling up the ends of the suspending chains and securing them, the rising of the water acting upon the floating vessels, lifts the wreck from the bottom; and while the tide rises, they proceed with their load towards the land, until the suspended vessel again rests upon the bottom, by the water becoming less in depth. Hence, they cannot, during one flowing tide, raise the sunk vessel more than the height to which the water had flowed from its lowest ebb, which at a maximum on the British coast does not exceed sixteen feet, and they must now suspend their exertions till the end of nearly twelve hours.

"Before that period arrives, however, a storm comes on, the workmen desist from their operations, and it not unfrequently happens, that before they can again commence their labors, the object of their toils has broken up, or has been imbedded in the sand.

"These inconveniences being obvious, I propose the following methods. The place of the wreck being ascertained by an improved drag, which at present I shall not describe, let her state be ascertained from a diving bell, and let there also be sent down with it a number of the before-mentioned buoys, in a perfectly collapsed state; and let the diving operator stow them away in that condition below decks, also hooking on as many about the ship as shall collectively be sufficient to buoy it up when inflated; for their inflation let him insert a small copper tube, which is attached to a leathern pipe,* into the nozle of each of the buoys (see engraving, fig. A), which pipe, communicating with the air within the diving bell (air being forced down into the steam-vessel†), will also inject air into the buoys, if they be held up, at the commencement of filling, a little higher than the level of the water at the mouth of the bell.‡ Or these envelopes may be speedily filled, by letting down a number of metallic vessels, charged with thirty or more atmospheres, which being discharged will quickly inflate them at the conveniency of the operator, by his turning a common stop-cock, which, in either of these methods, is all he has to do.

"Having, by one or other, or by both of these methods, filled a sufficient number of buoys, the wreck will begin to rise whenever the bags have displaced that bulk of water which is equal to the weight of the wreck while immersed in the same fluid. Let the

* Author of the excellent "Practical View of the Steam Engine."

† "Leathern bags, well sewed and tanned or barked in the best manner"—"made nearly air-tight, and proof against the attacks of vermin." [p. 5.] Mr. Milne, in a manuscript note on this passage, in our copy of the pamphlet, says: "Open-mouthed vessels of tin-plate would be preferable, to be inverted when in use, and packed into each other when not in use."—[ED. L. M. M.]

* This pipe should be sufficiently long to admit of the operator hooking on other buoys, while one bag is in the act of being filled with air.

† To be stationed over the sunken ship, (as explained in a preceding section of the pamphlet,) and provided with an air-compressing pump and a common blowing pump.—[ED. L. M. M.]

‡ Even the azotic gas discharged by the operators might be employed for this purpose; the quantity of common air deteriorated by them being very considerable. Pepys and Allen, in their Essays on Respiration, state that an easy inspiration is about 16 cubic inches, and that the subject of their experiments made about 19 of these per minute; for which it can be shown by calculation, that four men would discharge from their lungs, in one hour, a volume of air having a buoyant power equal to 2702.06 lbs. avoirdupois, or thereby.

weight to be raised from a depth of 65 feet be 300 tons avoirdupois, = 672,000 lbs. ÷ 64 lbs., the medium weight of a cubic foot of sea water, = the buoyant effect of 10,500 cubic feet of air discharged from the diving bell at that depth.

"But by using air previously compressed to thirty atmospheres, and discharged at the same depth, and by allowing the capacity of each vessel so charged to be $2\frac{1}{2}$ feet, then $27^{*} \times 2\frac{1}{2} = 67\frac{1}{2}$ cubic feet of air discharged from one compressed vessel, × 64 lbs., the buoyant effect of one foot of air in sea water, = 4,320 lbs. buoyant effect of air originally compressed into one vessel; but the load to be raised was 672,000 lbs., therefore, ÷ 4,320 lbs., = 155·5, &c. compressed air vessels, allowing the apparatus to have no weight of itself. I would also propose the use of such leather buoys for giving expedition to common diving bell operations, in bringing all kinds of goods, cannon, anchors, &c. from the bottom; and also for clearing such rivers as the Tay, below the town of Perth, and many such places, where navigation and the salmon fishing are greatly impeded by large stones at the bottom of the river. The stones might be Lewis'd† at low water, or they might be bored from a diving bell, the collapsed buoys made fast, and at convenience they could be inflated from a boat by a common forcing pump; the stones being suspended in the water may be towed to any place for the purpose of embanking, where they could be instantly sunk by pulling up the end of the escape pipe, B; the more immediate use of which pipe is to allow the superabundance of air to escape, which, while at the bottom of the sea, is compressed by the hydrostatic action of the surrounding medium; but immediately when the envelope begins to ascend with its load, the pressure of the water becomes less, and in the same proportion will the air expand within these bags, and ultimately would burst them, were it not that this pipe allows it to escape. It should be about nine feet long, having its lower end weighed down by a nose of metal, from which the air will always be retained within the bags till its expansive force becomes more than the pressure of water at the under orifice of this escape-pipe. Indeed, the maximum expansive force of air within its envelope may always be known by the length of this pipe B. Such an escape pipe must also be attached to each of the buoys employed in raising the wreck from the bottom of the sea. I shall only remark, that it would not be necessary for these buoys to be absolutely air tight, because they may be kept sufficiently full by the method already pointed out. Nor would there be any chance of their bursting by their buoyant power, which could never exceed the weight of their bulk, and they would require to be just as strong as to be capable of retaining water without bursting when filled with it, and suspended by their hooks from a pin in the wall. I would also propose the use of these buoys for floating the large stones which are used in forming sea-fences or dykes; the stones are usually carted from low water mark, but the method here proposed would be less expensive."

* The air-buoys being at a depth of 65 feet, would be compressed by the water with a force equal to the weight of two atmospheres

† A Lewis consists of three bars of iron, which are square on their section, when cut at right angles to their sides; these being placed side by side, form something like a dove-tail tenon; a corresponding mortice is cut in the stone to be raised, and the two outside bars are first placed within this aperture; the centre bar being throughout of equal thickness, is next placed between them, and a bolt with a clutch-ring is passed through the heads of all the three, by which the stones may be suspended. This instrument has long been in use, and is almost indispensable in a massive building.

On the Construction of Diving Bells. By S. D. To the Editor of the Mechanics' Magazine and Register of Inventions and Improvements.

SIR,—In the construction of the common diving-bell, an instrument now very extensively and importantly used, a complication of pullies, barrels, and ropes, always liable to accident and interruption, is necessary to insure a supply of pure air to the person in the bell, and to remove the impure air constantly generating. It has struck me sometimes—although from its not having been already adopted, there probably exists some insuperable objection to the proposal, which I do not perceive—that a condensing syringe might be used with great advantage. This syringe might work into a small reservoir above water, from which the communication (a well-constructed hose would serve every purpose) would proceed to the bell; this hose, it is evident, might be of any length, coiled even while in use on the deck of the lighter, which always accompanies the bell, and connecting by means of an opening in the top of the bell, to which might be attached a stop-cock, by which the person inside would always be enabled to govern the supply. For the removal of the impure air, a second set of hose should connect with a second stop-cock; the upper mouth of this set would be in immediate communication with the atmosphere, while the condensing syringe above was supplying the

bell with additional air, and thereby expelling from it additional water, the person inside would occasionally, at his discretion, open this second stop-cock, and allow a portion of the impure air to escape, which would be immediately replaced by pure air from the first set of hose, and thus a current of air might be created apparently more perfect, and attended with much less trouble than by the methods in present use. A sketch would more readily explain the simplicity of the mode; but a sketch requires a wood cut, and while doubting whether the idea is not open to some peculiar objection, I have not troubled you with one.

Very respectfully, Sir, S. D.

Boston, April 21, 1834.

On the Color of the Air and of Deep Waters, and on some other Analogous Fugitive Colors. By Count Xavier De Maistre. Translated from the Bib. Univ. by Prof. J. Griscom. [From the American Journal of Science and Arts.]

The blue color of the sky is accounted for, by supposing that the sun's light, reflected by the surface of the earth, is not entirely transmitted by the atmosphere and lost in space, but that the molecules of air reflect and disperse the blue ray. Why this ray is reflected in preference to the indigo and violet, which are more refrangible, and appear to be more easily reflected, is a circumstance not accounted for.

The same blue reflection is observed in deep sea water, and in lakes, and rivers, when they are limpid.

The same singular phenomenon is also witnessed in various substances of different natures, which have no apparent analogy: thus, opaline substances are blue by reflection; the noble opal, (independently of the partial rays which give so high a value to this stone, and which are attributed to natural fissures,*) reflects a general blue color, which is also observed in some other siliceous stones, and which is still more obvious in opaline glass. A weak solution of soap is slightly blue; the jelly of ichthyocolla is more so, and an infusion of the bark of the large chesnut tree, (*maronnier*,) which is perfectly opaline, still more. Newton speaks of a wood which he calls nephritic, the infusion of which is opaline. In the Sicilian sea, at the mouth of the Giaretta, (the ancient Simethus,) specimens of amber are found which are in great request on account of their highly opaline properties.

A blue reflection is also observed in certain bodies which are opaque-white when reduced to plates thin enough to transmit light. A familiar example occurs in the skin covering the veins, which transmits a blue, although neither the skin nor the blood is of that color.

The mixture of white with black and with transparent colors gives in painting numerous examples of opaline blue.

This blue color is the only one which can be explained on the theory of thin plates, by supposing that the particles of opaline bodies have just the dimensions requisite to reflect the blue ray. This explanation derives some probability from observing that the color transmitted by these bodies is the complementary yellow of the reflected blue. This theory, however, presents great difficulties, and it is not intended absolutely to admit it in this essay.

The analogy between the colors of opaline substances and those observed in the air and waters, will become obvious by an examination of their action on reflected and transmitted light, proving that the phenomena are owing to the same cause.

Opaline glass is produced by mingling in the common metal of white glass a portion of calcined bones, which gives a blue shade without much impairing the transparency. The bone powder appears to be in a state of extreme division, or a kind of demi-solution, which does not disperse the transmitted light.

The color of the light transmitted by opaline bodies varies according to the volume of the mass; it is yellow if the body is thin, and becomes successively orange and red in proportion to the increase of thickness. The analogy of the air with opaline substances is not only manifest in the blue reflection, but also in its action on transmitted light, which becomes successively yellow, orange, and red, according to the volume of air and the kind of aqueous vapors with which it is impregnated. When the sun is high, and his light crosses only the purest and thinnest portions of the atmosphere to reach the clouds, they are white, with a slight tinge of yellow; they become sometimes yellow and orange as the sun declines; and at length red and purple when his light grazes the earth, and is transmitted by the densest portion of the air, and loaded with the vapors of the evening.

But it often happens that the colors do not appear, and that the sun sets without producing them. It is not, therefore, to the purity of the air alone that we must attribute the opaline property of the atmosphere, but to the mixture of air and vapor mingled

* This was the opinion of the celebrated Haüy.

in a special manner, and producing an effect similar to bone dust in opaline glass; neither is it the quantity of water in the air which occasions the colors, for when the weather is very damp it is more transparent than during a time of drought. Distant mountains are seen more distinctly, a well known prognostic of rain; the sun then sets without producing colors, it looks white through the fog and damp vapors of the morning, but when the clouds are colored red by the setting sun, the phenomenon is generally deemed the signal of fine weather, because these colors are a proof of the dryness of the air when these contain only the peculiar diffused vapors which give it its opaline quality. In this state of things the disc of the sun appears like a red fiery globe divested of rays.

The blueness of the sky, therefore, varies according to the kind of vapor which is spread through the air; and what renders it unquestionable that its blue color is caused by these vapors is, that it appears black when seen from the highest points of the globe, above which there is not sufficient vapor to reflect the blue color.

Limpid waters, when they have sufficient depth, reflect like air a blue color from below; it is of a deeper shade, because it is not mixed with white light; very often it is not perceived at all; the reflection from the surface, on which the sky and surrounding objects are painted as in a mirror, often occasions the disappearance of the internal reflection, or forms with it complex shades.

We have seen that the property which air possesses of producing colors is derived from the presence of watery vapor; analogy leads us to presume that this property in water arises from a mixture of air which it always contains to a greater or less amount.

Although the blue color of water is often masked by numerous causes, it is sometimes exhibited in all its intensity; a fine example of it is witnessed in looking at the Rhone from the bridge at Geneva. The river seems to flow from an ultramarine* source. The spectator is in the most favorable situation for observing the internal reflection disengaged, as much as possible under an open sky, from the reflection at the surface.

Agitation of the surface has a great effect on the color. A tranquil sea sometimes reflects the warm color of the horizon, representing all the tints of a luminous sky so exactly, that the sky and sea appear to be blended with each other; but if a gentle breeze ruffles the surface, the brilliant tints vanish, and the blue from the interior immediately predominates.

Such is also the cause which enables one to distinguish the course of the Rhone far into the waters of the Leman: the progressive motion of the river in the motionless water of the lake produces an agitation which diminishes the brilliant reflection of the sky and renders the color of the water more sensible.

The green tint which the sea often assumes may seem to throw some doubt on this property of reflecting the blue ray, regarded as inherent in the nature of water; but this green color is observable only when the depth of the sea is insufficient, that is, when the bottom may reflect the transmitted light.

In looking at the sea from an elevation of about fifty toises, on the shore of the island of Capri, I observed spots which were of the finest green, much more luminous than the dark blue sea with which they were surrounded. To ascertain the cause, I took a boat and proceeded to the place. The spots then were no longer perceptible, but I soon re-discovered them, and found that the color was occasioned by white rocks, which were easily distinguished, notwithstanding their great depth, from the dark sandy bottom in which they reposed. These rocks, viewed in a vertical direction, were of a lighter green than when seen from the height, but I could not doubt that they were the cause of the phenomenon.

To settle the point by direct experiment, I prepared a square sheet of tinned iron, fourteen inches long, painted it white on one side, suspended it horizontally to a cord, and sunk it in a deep place, where the water under the boat was blue, without any mixture of green, watching the effect under the shade of an umbrella which was held over my head. At the depth of twenty-five feet it acquired a very sensible green tinge, and this color became more and more intense to the depth of forty feet, when it was of a beautiful green, inclining to yellow; at sixty feet the color was the same, but of a darker shade, and the square figure of the plate was no longer distinguishable; until at eighty feet there was apparent only an uncertain glimmering of green, which soon disappeared.

We thus perceive that the light of the sun transmitted through water, and reflected from a white surface, produces green. The cause may be readily conceived by admitting in deep waters the same opaline property which we recognize in air. The light, after penetrating a mass of one hundred feet of water, to reach the plate and return to the

* Having the blue color of the ultramarine paint.

surface, ought to be yellow, like that which would be transmitted by an opaline fluid; this color reflected by the plate, mixed with the blue which reaches the eye from all quarters, produces the green. If the bottom of the sea were white, like ceruse, the waters near the shore would present the same green tint which the plate produced at different depths; but the bottom is generally of a dark grey, which reflects less light, and therefore yields only a dark and uncertain green: hence the green color of the sea, as witnessed near the shore, is owing to the reflection of light from its bottom. To leave no room for doubt in this matter, I took a boat and pushed out from the shore, under a clear July sun, at eleven in the morning, to examine the changes which might be perceptible in the color of the water viewed on the side of the boat opposite to the sun.

At fifty toises from the shore the water was decidedly green, the shade of which remained during fifteen minutes; it then became a bluish green, and, in advancing, the blue continued to increase, and at length to predominate, and in an hour's time the water under the boat was a pure blue without a mixture of green.

In returning to the shore I was attentive to he re-appearance of the green, and as soon as I found it clearly marked I sounded and found the depth one hundred and fifty feet; thus the light which renders the sea of a green color passes through three hundred feet of water. But in that part of the gulf another cause contributed to the green color, viz. the impurity of the water as it exists to the extent of some miles from the shore. The bay of Naples receives no river that can give motion to the waters charged with all the filth of that populous city. On the shore of the islands of Capri the water is perfectly blue at eighty feet, while near Naples it requires one hundred and fifty feet, a difference which must be ascribed to the impurity of the water in the bay.

If the bottom be of a black, or very dark color, the water may be blue at a much less depth than eighty feet. Besides, if an obstacle intercept the direct rays of the sun, so as to throw a shade over the bottom, while the water itself is illuminated, the latter will be blue, because no longer colored by yellow rays from the bottom; this effect may take place near shore in deep waters, by projecting cliffs or high shores.

It is thus ascertained, that when the sun's light transmitted through water is not lost in its depth, but is partially reflected by the bottom, the water is of a green color.

This effect may arise in deep water from beds of submarine plants, or by myriads of microscopic mollusca, which, covering a vast extent of sea, may act upon the light, or even exist in mass sufficient to produce a permanent color.*

The colors transmitted by deep waters cannot be directly observed like those of air, which are visible among the clouds; observations agree on this point. The learned Halley, in descending in a diving bell, observed that a ray of light, which reached him through a small opening closed by glass, gave to the upper part of his hand a rose color. Had his hand been white, instead of being itself more or less red, the experiment would have been more conclusive. The depth to which he descended was probably not more than thirty or forty feet, at which the transmitted light could not differ much from yellow, which, mixed with shades of white, and with the natural color of his hand, would produce a rosy tint. He observed that the under part of his hand was green, which must have been occasioned by reflection from the bottom.

The bluish green color of crevices in the glaciers is occasioned in the same manner as that of water near shore; if the mass of ice was as great and as homogeneous as that of the sea, the interior of the crevices would be blue; but the ice contains air bubbles, particles of snow, and fissures which reflect the transmitted light, throwing it from one face to another of the crevice until it finds an escape. These opake substances in the glacier produce the same effect as a white surface in the depths of the sea.

There is on the shore of Capri a grotto, which nature seems to have constructed to exhibit in all its beauty the green color of the sea, and which on this account is called the *azure grotto;* it is situated under a cliff on the north side of the island. As it could not be entered by a common boat, it remained unknown until 1826, when two Prussian artists, Kopitch, and Frisi, swam into it, and made it known. Their account excited public curiosity, and boats of convenient size were made, which now serve to introduce amateurs. Its entrance is triangular, having a base of four feet five inches wide and about the same height. The summit is rounded, and having but little thickness the entrance is easily effected by stooping, when the traveller finds himself in a spacious grotto, the sides and roof of which

* The theory of the author derives confirmation from the beautifully green appearance of large fish as they turn upon their backs in rising towards the surface, and sporting round a ship, during her passage through a dark blue sea.—[Trans.]

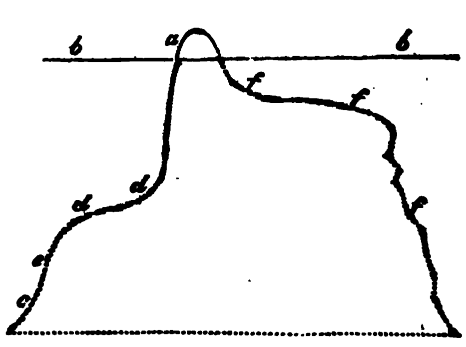
are remarkably regular. Its extent from the front to the rear, which is the only landing place, is one hundred and twenty-five feet, and it measures one hundred and forty-five feet in a transverse direction. The depth of the water at the entrance is sixty-seven feet, in the middle of the grotto sixty-two feet, and at the landing place fifty-eight feet. The rock is limestone, of a clear grey fracture, and there are no indications of stratification.

On entering, every thing appears dark except the water, which is luminous, and of a splendid blue, contrasting with the general obscurity. In advancing from the entrance, the ends of the white oars shine in the water with a splendid blue light, which disappears as soon as they are raised: this is the most singular phenomenon of the azure grotto, for people are puzzled to conceive why objects are so vividly luminous in the water, and no longer so when above the surface. In dipping the hand or a cloth into the water, one would think it a blue dye; the whole immersed part is luminous and colored, while the parts without are dark and uncolored.

At the bottom of the grotto there is a small space on a level with the water, where debarkation is effected, and which is the only spot which leads to any suspicion of the work of human hands in the grotto. It is a kind of bench in the rock, about three feet high, on which several persons may conveniently place themselves and examine at leisure the phenomenon of the azure grotto. The light, which comes in at the small opening, produces a train of white light, like the reflection of the moon from the water when rising, and which extends half way over the sheet. The rest of the surface is blue, even to the feet of the observer. This color gradually diminishes to the right, where the walls of the grotto are farther from the entrance. The train of white light illuminates also the vault, and exhibits it in its natural color, but when the entrance is closed by a boat, or more perfectly by a dark cloth, the vault itself becomes blue, reminding one of the effect of burning spirits of wine in a dark chamber. There is, then, no light but that which proceeds from the water. The experiment of the cloth ought to be made by all who wish to enjoy the spectacle in its full beauty.

If, when the observer is seated on the bench, a boat passes in front, it forms no reflection nor shade in the water. If the eyes are then covered with the hands, so as to hide the boat and the water, the former appears suspended in the air like a dark silhouette crossing the sky. This spectacle is so striking when first observed, that one cannot avoid some apprehension on account of those who furnish the occasion of it. In passing to the dark side mentioned on the right, the water is no longer blue, but remarkably transparent. The rock below is so illuminated as to show its fissures at a considerable depth, while above the water it is very obscure. The water line is clearly marked, and has a yellowish tint. The depth seems to increase the longer it is observed, and at length the bottom is seen, although forty feet below. The white plate which I let down was very distinguishable on the darker sand. Its color, instead of being green, as when tried in the sun, was slightly yellow.

The feeble yellow light which illuminates the submarine walls in this part of the grotto, proceeds by reflection from the bottom, and from the walls opposite, which receive the exterior light; this light, which has traversed a great mass of water, should be yellow, like that transmitted by opaline fluids, and thus the opaline quality of the sea affords a satisfactory explanation of the principal phenomena of the grotto. I have endeavored to give an idea of this construction by means of the subjoined figure, which represents the exterior rock or shell of the grotto, as it exists both in the sea and above the surface.



The little entrance is shown at *a*, above the level of the sea, represented by the line *b b*. The eastern side of this entrance extends almost perpendicularly to the depth of thirty or forty feet, when it appears to be cut horizontally at *d d*, and suspended on the dark blue water of the sea; *d e c* is the supposed continuation of the eastern side of the entrance, to the bottom, which, as we have seen, is sixty-seven feet deep. The western side of the entrance, *f f f*, forms an angle at ten or twelve feet below the surface, and is prolonged horizontally from twenty to twenty-five feet, and then descends

obliquely, probably to the bottom of the sea, where it cannot be seen beyond thirty or forty feet.

This construction gives an immense opening for the light to enter the grotto through the water, even when the little opening above the surface is closed, and it thus occasions, over a great mass of water, that dispersion of the blue ray which always takes place in deep and limpid waters, and which is manifested in greater splendor in the azure grotto in consequence of its being mingled with no other light.

Having considered the opaline property of air and water, let us now examine the production of opaline blue in opake bodies.

The cause of the blue tint assumed by the fine skin which covers the veins has hitherto been a doubtful question. This phenomenon, which is uniformly connected with the opaline property of the skin, is mentioned by Leonard De Vinci; let us first see the conditions under which it exists.

First, the vein must be deep enough to absorb all the light transmitted by the skin; and the skin must have the thinness requisite to transmit a great portion of the light. If the vein is thin, it reflects the color of the blood and becomes red;* this color, mixing with the opaline blue of the skin, forms those violaceous tints observable on the countenances of persons of dark complexion (brouille). If the vein is still thinner and nearer the epidermis, the transparency of the skin increases and the red color is more distinct; finally, a tissue of imperceptible veins, very near the surface of the skin, colors the cheeks and lips of young people of a fine complexion, with a uniform red; but we may observe that these beautiful colors have not the exact tint of the blood which produces them; it partakes of the opaline blue, which renders the color slightly carmine, and tinges sometimes the lips of sanguine people of a purple or violet hue.

Thus, the difference which may exist in the size of the blood vessels, and in their proximity to the surface, is sufficient to produce all the shades of blue, violet, red and purple, which are seen in the human face, by the mixture of the opaline blue of the skin with the red of the blood.

The red color of the blood is not the cause of the blue tinge of the veins; it might be black or green without occasioning any change; it is enough that the coloring principle absorbs all the light transmitted by the skin. This result may be artificially produced by a very thin plate of ivory, which has nearly the same effect as the skin. If a few drops of ivory black, prussian blue, cochineal, or bile, sufficiently dense to be opake, be placed on one of its surfaces, they produce alike a blue tint on the opposite surface, because they equally absorb all the light transmitted by the ivory. But if, instead of a coloring matter which absorbs light, we use an opake reflecting coloring substance, we have a tint compounded of opaline blue and that of the color employed.

The red oxide of lead placed on the ivory gives on the opposite surface a slight tinge of carmine. Some painters avail themselves of this property of ivory, in sketching the cheeks and lips of their portraits, by placing a coat of minium on the opposite surface, and thus obtain indirectly the effect of a slight use of carmine.

But if, instead of minium, Naples yellow be put on, there is on the opposite surface a green spot. In both these cases, then, the opaline blue is mingled with the proper tint of the opake reflecting color, while the blue alone appears when the applied color absorbs the light transmitted by the ivory.

The mixing of colors in oil painting furnishes still more evidently an opaline blue. The most common case is the mixture of white with vegetable black, which produces a bluish shade. Various writers have adverted to this, and as indigo and prussian blue, in mass, approximate to black, it was thought in former days that blue was a mixture of light and shade; but the blue produced on this occasion belongs exclusively to white and not to black, as is proved by the following process: two plates are painted of a grey color, one by a mixture of ceruse and charcoal ground in oil, the other by superadding to a coat of white a glazing of charcoal, so that they may both have the same depth of shade; the first will be bluish, the second grey, without a mixture of blue.

As transparent colors in oil lose almost wholly the color which they have in a pulverulent state, and thus in mass approach to black, the mixture of them with white produces also opaline blue, which modifies the natural shade of the color.

Every painter knows the striking difference there is between the color of a mixture of cochineal lacker with white, and that which the same lacker produces as a thin coating upon a white ground; the first is of a violet color, and the second has all the purity and splendor which is characteristic of this fine color. Thus artists, who wish to obtain the beautiful red of cochineal or madder in their draperies, always employ these lacks.

* It is thus that a wide barometer tube, filled with colored wine, appears black, while a thin thermometer tube, under like circumstances, is of a beautiful purple.

ers in mixture (en glacis). Opake reflecting colors, such as Naples yellow, chromate of lead, yellow ochre, produce, as well as white lead, opaline blue, by a mixture with black, and the effect is still more sensible. These compounds, according to theory, ought to give only shades of yellow; and yet their tints are decidedly green, so that they are often used for painting the deepest verdure of landscapes. In these cases it is the opake reflecting color which is opaline.

I have stated the most remarkable instances of the singular property which certain colors possess of producing opaline blue by mixture, but there is an infinite number of other modifications less apparent, resulting from mixtures of compound colors, which it would be impossible to describe, but which may always be pre-ascertained by the following rule: *When white lead or opake reflecting colors are mixed with black, or with transparent colors, there is a production of blue, and a consequent modification of the primitive shade of the coloring matter.*

These modifications are often very slight, but they do not escape attentive observers. In the preceding observations I have described effects, well known, it is true, but which appear to have no analogy to each other, and which appear to me to depend wholly on the peculiar property which the blue ray possesses of being reflected, in preference to other rays more or less refrangible, by the simple mechanical resistance of the molecules of bodies which transmit light. This resistance takes place in large masses of transparent fluids, as in air mixed with watery vapor, and in water mixed with air.

It takes place also in opake bodies which are less transparent, but under smaller dimensions. Lastly, it is observed in white opake or colored bodies, as in the fine skin which covers the veins, and in mixtures of colors.

A Compendium of Civil Architecture, arranged in Questions and Answers, with Notes, embracing History, the Classics, and the Early Arts, &c. By Robert Brindley, Architect, Surveyor, and Engineer. [Continued from page 206.]

PERPENDICULAR ENGLISH STYLE.

Q. What is to be advanced on this style?

A. At the close of the fourteenth century, flowing lines gave way to perpendicular and horizontal ones.

Q. How long does the perpendicular style appear to have been in use?

A. As far as 1630 or 1640; but only in additions. Probably the latest is not later than Henry VIII., on account of the gradual introduction of Italian architecture.

Q. What distinction is marked in the doors from the former style?

A. The constant square head over the arch, which is surrounded by the outer moulding of the architrave, and the spandrill filled with some ornament, and over all a dripstone is placed. In large rich doors a canopy is sometimes included in this square head, and sometimes niches are added at the sides, as at King's College chapel, Cambridge. The shafts are small, and have plain capitals, oftener octagonal, and the bases made so below the first astragal. The architraves consist of ogee mouldings.

Q. How are the windows distinguished?

A. Very easily—by the mullions running in perpendicular lines, and the transoms, which are now general. The varieties of the last style were in the disposition of the principal lines of the tracery—in this style, in the disposition of minute parts. A window of four or more lights is divided into two or three parts, by stronger mullions running up, and the portion of arch between them doubled from the centre of the side division. In large windows the centre one is again made an arch. Often, in windows of seven or nine lights, the arches spring across, making two, four, or five lights in the centre belonging to each.

Q. How are the heads of the windows described?

A. Instead of being filled with flowing ramifications, they have slender mullions running from the heads of the lights, between each principal mullion; and these have small transoms. The entire window is divided into a series of small panels—the heads being arched are trefoiled or cinquefoiled.

Q. What also is peculiar in the buildings of this era?

A. The window and its architrave completely fill up the space between the buttresses. The east and west windows are very large. St. George's, Windsor, has fifteen lights in three divisions. The east window at Gloucester is also very large.

Q. Of what character are the arches?

A. The four-centred is much used, but varying amongst the ornamental part of niches. The arches, used in the division of the aisles, form a great distinction in this style, by the constant use of mouldings running from the base all round the arch, without any stop horizontally, by way of capital—sometimes with one shaft and capital, and the rest of the lines running. In window arches shafts are seldom used; the archi-

traves run all round, and all the arches are enclosed in squares with ornamental spandrills.

Q. What is another distinction of these arches?

A. In large churches, the absence of the triforium between the arches of the nave and the clerestory windows. The place is supplied by panels, as at St. George's, Windsor, and Henry VII.'s chapel.

Q. Of what description are the piers?

A. In this style they are thinner between the arches than the former, and the proportion the other way, from the nave to the aisle, increased by having those shafts which run to the roof, to support the springing of the groins, added in front, and not forming part of the mouldings of the arch, with a bold hollow between them, as at King's College chapel, Cambridge; St. George's Windsor; and Henry VII.'s chapel. In small churches, the pier of four shafts and four hollows is much used.

Q. What variation is there in the buttresses?

A. Triangular heads are less used in the stages. Pinnacles are freely adopted; the whole differing but little from the last style.

Q. What of the cornices?

A. They are composed of many mouldings, ornamented with flowers and grotesque animals, similar to the preceding style; the dripstones are also the same.

Q. Describe the niches.

A. They are numerous: simple recesses having ogee canopies; others overhanging square headed canopies.

Q. What of the ornaments?

A. They consist in panelling in one general series. King's College chapel, Cambridge, St. George's, Windsor, and Henry VII.'s chapel, illustrate them. Another peculiar ornament is the angle-cornice, as at Windsor, and Henry VII.'s chapel. Crockets were formed in this style; those of pinnacles were much projected.

Q. What may be said of the steeples?

A. They possess little variation from the earlier dates.

BATTLEMENTS.

Q. What descriptions of battlements are there?

A. The Norman; which appears to have been a plain parapet. An ornamental parapet continued to be used through the following styles, but with the frequent use of battlements, of several sorts, both plain and pierced; even towards the perpendicular style, it continued with less alterations than any other parts.

Q. Of what character is the most frequent early pierced parapet?

A. It is a series of interchanged trefoils, with a serpentine line separating them, and mostly used in decorated English buildings. In the perpendicular, the dividing line is straight, making a series of interchanged triangles. The early pierced battlements have quatrefoils, with a cap-moulding running round. There are also pierced battlements, not with straight tops, but variously ornamented. The tudor flower is also used as such.

Q. Of what description are the plain battlements?

A. Several: 1st, that of nearly equal distances, with capping round the outline; 2d, the castellated battlement of nearly equal intervals—the cap-moulding running horizontally; 3d, a battlement similar to the last, but the mouldings running quite round; 4th, a battlement with cap-moulding broad—of several mouldings, and running round the outline, narrowing the intervals, and enclosing the battlements.

ROOFS.

Q. How may the roofs be divided?

A. Into two divisions: 1st, the sloped framing, carrying the lead visibly; 2d, the inner roof of different materials.

Q. What of the Norman roof?

A. This was quite plain. The only original one is in Rochester cathedral.

Q. Where is a specimen of the ornamented open roof?

A. At St. Stephen's.

Q. What of the inner divisions of roofs?

A. They vary: the first described is flat over the ties, planked, and painted, as at St. Albans.

Q. What is the next description of roof?

A. The regular groined roof, of which we have a series, from the plain Norman arched to the pendant roof of Henry VII.'s chapel.

Q. What afford a good description of roofs?

A. The Norman crypts: the first to be noticed has four cross springers, without straight ribs, from the opposite piers; the next is the plain rib, running longitudinally at the top, crossing the ribs from the piers, and also the intersection of the cross springers; another rib runs crosswise at the top of the window-arches, crossing the centre intersection.

Q. What is the next description?

A. The fan-tracery. In these roofs, from the top of the shaft, springs a small fan of ribs, without doubling out from the points of the panels—ramifying on the top; and a

quarter or half-circular rib forms the fan: and the lozenge interval is formed by some of the ribs of the fan running through it, and dividing it into portions filled with ornaments. King's College chapel, Cambridge, Henry VII.'s chapel, the Abbey church, at Bath, and Gloucester cloisters, are fine specimens.

Q. What of the arched roof?

A. It is used in small chapels. The roof of the nave of Bath is a beautiful illustration. The arch is very flat—composed of a series of small rich panels.

Q. How are the ribbed roofs formed?

A. Often of timber and plaster—generally colored to represent stone works.

Q. In describing the several styles is there not a probability of mixing one with the other?

A. Yes; as one style gradually passed into another, there will be here and there buildings partaking of two. Litchfield cathedral is a fine instance of the gradation from richer early English into decorated English. There are also many beautiful gradations from decorated to perpendicular, as exemplified in the choir, York.

A. What is to be observed on the alterations and additions which most ecclesiastical edifices have received, in judging of their age?

A. The general alteration is that of windows, which is most frequent. Very few churches are without some perpendicular windows; and it may therefore be concluded that the building is as old as the windows, or that part connected with the windows. Doors cannot so well be distinguished, being often left much older than the rest of the building.

Q. What also is to be observed on the locality of styles?

A. It is perceptible in every country. Where flint abounds it is difficult to determine the date of churches, having no battlements, arches, or buttresses. Where stone is used, there is a sufficient criterion to determine on the style. Due attention to correct plates, and habitual observation, will enable the connoisseur to determine the era of every edifice.

Q. What building of the fifteenth century deserves particular notice?

A. Roslyn's chapel at Woodstock. It is singular in its character, ornaments, and plan, and is unclassable as a whole, being unlike any other in Great Britain. The ornamental work completely accords with the style then prevalent, though debased by the clumsiness of the parts, and the want of proportion to each other. No doubt but it was designed from some foreign building.

ELIZABETHIAN STYLE.

Q. What style intermediate the latter part of the fifteenth and the commencement of the sixteenth century calls forth attention?

A. The Elizabethian style—partaking of the four precursory styles, yet claiming an originality of its own.

Q. What are the prominent features of this style?

A. The square panelled mullioned windows, and wooden panelled roofs of walls. This style, however, appears to be confined principally to domestic habitation, rather than ecclesiastical edifices.

Q. What is the character of these buildings?

A. The walls are generally of brick, finished with battlements, angular, semi-circular, and compound pediments. In many instances each story is corbelled one over the other. The roofs are high pitched, containing checket or spandrill windows. The apertures for windows are very large, as also the doorways. The interior arrangements of these buildings approximate more to domestic comfort, representing the capacious homely hearth; whilst the wooden panelling, with carved devices, enclose the naked walls. The introduction of oak and deal flooring substitutes that of stone.

Q. Where is this description of building to be found?

A. In ancient cities and towns, but more particularly amongst the mansions of the great scattered throughout the country, and rising amidst woods, on hills, and in dales, with their ivy-clad walls, so enchantingly, that even modern architecture, in its most splendid attire, succumbs to the antique form, in commemoration of the good and happy days of yore.

GRECIAN AND ROMAN ARCHITECTURE.

Q. At what period was the antique, or Grecian and Roman architecture, introduced into England?

A. In the time of James I., 1626.

Q. How was it introduced?

A. First, only in columns of doors—afterwards, in large portions.

Q. Where is the most memorable specimen?

A. In the celebrated portico of the schools at Oxford, where a building, adorned with pinnacles, having mullioned windows, has the five orders introduced over each other.

Q. What marks the complete introduction of the antique workmanship?

A. The Banqueting House, at Whitehall, and at the close of the seventeenth century this splendid architecture was finally estab-

lished in one of the most magnificent modern metropolitan buildings we possess.

Q. What is to be understood by the word *order*, as applied to the Grecian and Roman architecture?

A. It is so denominated from the different ornaments peculiar to each production. The number of columns, windows, &c. may be the same in either order, only varied in proportion.

Q. How are the orders generally considered?

A. To be five: *Tuscan, Doric, Roman, Corinthian*, and *Composite;* to which may be added the *Roman Doric*, and the *Roman Ionic*.

Q. How are these orders distinguished?

A. The *Tuscan*, quite plain; the *Doric*, by the triglyphs in the frieze; the *Ionic*, by the ornaments of its capital, termed volutes; the *Corinthian*, by the superior height of its capital, and ornamental leaves; the *Composite*, by the large volutes of the Ionic capital; the *Roman Doric*, by the triglyphs, metopes, and mutules; and the *Roman Ionic*, by the volutes of the capital. In short, the capitals wholly denote the orders.

Q. How is a complete order divided?

A. Into three grand divisions, which are occasionally executed separately. First, the column, including its base and capital; second, the pedestal, which supports the column; and third, the entablature, or part above, supported by the column.

Q. How are these subdivided?

A. The *pedestal*, into *base or lower mouldings;* the plain central space, into *dado* or *die;* and the upper mouldings, into *surbase*. The *columns*, into *base and lower mouldings; shaft*, or central plane space; and *capital*, or upper mouldings. The *entablature*, into *architrave*, or part immediately above the column; *frieze*, or central flat space; and *cornice*, or upper projecting mouldings.

Q. How are these parts again subdivided?

A. First, the lower portions, viz. base of pedestal, base of column, and architrave, divided each into two parts: the first and second into plinth and mouldings, the third into faces and upper moulding, or tenia. Second, each central portion, as dado of pedestal, capital of column, and cornice of entablature, divides into three parts: 1st, into *bed-mould*, or part under the corona; 2d, corona, or plain face; 3d, *cymatium*, or upper moulding. Third, the *capital*, into *neck*, or part below the ovolo, or projecting round moulding, and *abacus*, or tile, the flat upper moulding, mostly nearly square. These divisions of the capital, however, are less distinct than those of the other parts. Fourth, the *cornice*, into *bed-mould*, or part below the corona; *corona*, or flat projecting face; *cymatium*, or moulding above the corona.

Q. What are the ornamental mouldings round windows and doors designated?

A. *Architraves*.

Q. What is the ornamental moulding from which an arch springs called?

A. The *impost*.

Q. What is the stone at the top of the arch?

A. A *key-stone;* and the ornament carved on it a *console*.

Q. What are the small brackets under the corona in the cornices?

A. *Mutules*, if square or longer in front than in depth; as used in the Doric order. If less in front than their depth, *modillions*, and have carved leaves under them, as in the Corinthian order.

Q. What is a *truss?*

A. A modillion enlarged and placed flat against a wall, to support cornices. When used under modillions, in the frieze, trusses become *cantilivers*.

Q. What is the *soffit?*

A. The space under the corona of the cornice ; also, the under side of an arch.

Q. What are *dentils?*

A. Ornaments used in the bed-moulds—parts of a small flat face cut perpendicularly, and spaces left between each.

Q. What is the *Attic order?*

A. A minor order invented by the Atticæ, a people of Greece; it consists of short pilasters, forming a small height of panelling above the grand entablature, and is again raised on the summit, which forms an architrave cornice. These panels have, sometimes, introduced between them small pillars, designated *balustres;* a series of them form a *balustrade*.

Q. What is the *Persic order?*

A. It is delineated by columns, constructed in the form of men, supporting an entablature, and is said to have originated from Pausanias defeating the Persians, when the Lacedemonians, as a mark of victory, erected trophies of the arms of their enemies, and represented the Persians under the figures of slaves, supporting porticos, arches, or houses.

Q. Of what order is the *Caryatides?*

A. The columns are in the form of women with their arms cut off, and with garments reaching down to their feet. This order arose from the inhabitants of Carya, in Peloponesus, having joined the Persians against their own countrymen. The Greeks were totally defeated. The victors put the men to the sword, and carried off the women

in triumph; and the more to perpetuate this action, they represented these women, in their triumphal vestments, supporting the heavy weight of edifices.

Q. What are *Termini?*

A. Figures of human heads, without feet or arms. Such was the representation of Terminus, a divinity of Rome. His temple was on the Tarpeian rock; he presided over land marks, and is thus represented, intimating that he never moved, wherever he was placed.*

Q. What is a *pilaster?*

A. A flat column of the same proportions as the circular columns, and decorated in like order, presenting itself one quarter of its thickness from the surface of the wall, and used for convenience and economy. Those, however, which have a different capital are called *antæ*, and are undiminished.

Q. What are *pediments?*

A. Flat angular spaces of masonry, surmounting the columns and entablatures of the portico, and have cornices containing either mutules, modillions, or dentils. Such in the raking cornice must be placed perpendicular over the like in the horizontal line; and their sides perpendicular, though their under parts have the rake of the cornice. The interior part is sometimes *grouped.*

Q. What are the joints of masonry channelled termed?

A. *Rustic work*, or rusticating.

Q. How are columns ornamented?

A. Sometimes by channels, termed *flutes;* these channels are partly filled by a lesser round moulding, which is known as *cabling* the flutes.

Q. What are the different mouldings which, by different combinations, form the several parts of the orders?

A. *Ovolo*, or quarter round; *cavetto*, or hollow; *torus*, or round. These are the most simple, and from the composition of them are formed divers others; and from an arrangement, with plain flat spaces between, are formed cornices and other ornaments.

Q. What is a large flat space designated?

A. A *corona*, if in the cornice; a *fascia*, if in the architrave. The frieze itself is only a flat space.

Q. What is a small flat space termed?

A. A *fillet* or *listel;* and interposes mouldings to distinguish them. A fillet is, in the base of columns and some other parts, joined to a face, or to the column itself, by a small hollow then called *apophyge.*

Q. What is an *astragal?*

A. The torus, when it becomes very small, and projects. And the torus is a *bead* when it does not project.

Q. What are *compound mouldings?*

A. The *cima recta*, which has the round lowermost, and projecting; the *cima reversa*, or ogee, which has the round uppermost, and projects*—the *scotia* which is formed of two hollows, one over the other, and of different centres.

Q. What are *reedings?*

A. Several beads sunk on a flat face.

Q. What are *enrichments?*

A. All these mouldings, except the fillet, when they are carved.

Q. What is the difference between the Grecian mouldings and those of the Roman?

A. Those of the former are bold and worked with a small return, technically termed a *quirk*, and are of various proportions; whilst the mouldings of the latter are generally worked of equal projection to the height, and not bolder than above regular forms. The ogee and ovolo are most generally used.

Q. How are the several orders, with their component parts, proportioned?

A. Vignola, with a view of preventing those mistakes which often arise from the different measures which, in different nations, bear the same name, invented a mode of division, termed *module* (from *modulus*, signifying measure, due proportion,) and a measure now used by all architects.

Q. What are the proportions?

A. The module of the Tuscan and Grecian Doric is equal to *one half* the diameter of the bottom of the shaft, which module is subdivided into *thirty minutes*. The module of the Ionic, Corinthian, and Composite, is equal to the whole diameter of the bottom of the shaft, and is subdivided into *sixty minutes*.

Cast Iron Pumps.—The following drawing represents a pump about two and a half feet high, and is designed for cisterns, particularly in kitchens, barns, green-houses, and other out buildings. The pump may be placed within the building, and the water drawn from a cistern without the building by the aid of a bended tube of copper or lead. The following are the directions for setting and using.

Unscrew the three screws in the bottom of

---

* These three orders of figures are seldom used but in mantel-pieces, or as *trusses*, to support cornices to monuments, and for gardens. The two former, however, are introduced into one of our modern edifices of religion.

* The moulding under the cymatium, which in rich orders is often an ogee, is part of the corona, and as such is continued over the corona in the horizontal lines of pediments, where the cymatium is omitted; and is also continued with the corona in interior work, where the cymatium is with propriety omitted.

the pump, and it will then be separated into three parts.

After placing the pipe into the well, carry the other end through the floor and sink, or where you wish the pump to stand; then put the bottom plate over the end of the pipe about three-fourths of an inch, and with a piece of wood the shape of an hen's egg, you will easily bend the lead into the place left in the plate for it; then hammer it down level with the top of the plate, and screw down the plate with wood screws, placing a piece of leather or cloth under the plate to make it tight, if it is set in the bottom of the sink; then place the leather valve and pump as you took them apart, and screw them together tight, after having wet the leather in warm water.

The pipe should be placed a little descending from the sink to the well, so that the water will run out freely when necessary. This pump is so constructed, that by raising the brake clear up, the valves are opened, and the water passes off immediately out of the pump and pipe, which operation is necessary in cold weather to prevent it from freezing.

Manufactured by Scott, Keith & Co., East Bridgewater, Mass., Patentees, and sold by H. Huxley & Co. 81 Barclay street, New-York. Price, small size $8; large size $10.

THE ENJOYMENT OF READING.—We said a word or two on this subject in our preceding volume; and on account of its great importance to every individual, we cannot help again adverting to it. We recommend those who have not taken the *Penny Magazine* from its commencement, at least to purchase No. 95, for September 28, 1833. It is most gratifying to reflect that there is not a human being, endowed with health and the ordinary condition of the human faculties, that may not participate in what Sir John Herschel appears to consider the greatest of human pleasures. It is delightful to foresee that, when the whole of society shall be so far educated as to derive pleasure from reading, and when books are as common as bread and potatoes, the hardest-worked agricultural laborer or mechanic, when he goes home from his day's toil, may plunge at once into intense enjoyment by taking up a book. The most gratifying circumstance respecting this enjoyment is its universality, and its applicability to all countries, all future ages, and to every human being in tolerable health and above destitution. It is equally applicable to man, whether in prosperity or in adversity; whether in prison or free; and even, to a certain extent, whether in health or sickness. Another gratifying prospect anticipated from the result of universal reading is, universal improvement of worldly circumstances. Let any taste become general, and the regulations and habits of society will accommodate themselves to that taste. The hours of labor, at present, afford barely time for eating and sleeping; but when reading becomes a necessary of life to every, even the lowest, class of society, they will be reduced so as to afford time for that enjoyment also. Surely, if nothing else were to be gained by a system of national education, but the power of conferring so much happiness on millions, it would deserve the patronage of every benevolent mind, and be worthy the adoption alike of governments professing to be paternal or to be representative. But the main object which we have now in view is to impress Sir John Herschel's statement strongly on the mind of the young mechanic, so as to encourage him, above all other earthly things, to cherish a taste for reading in himself, and in all those with whom he may have any thing to do. Another point to which we wish to direct attention is the necessity, when a national system of education is established, of adding to every school, not only a garden, a workshop for teaching the simpler operations of the mechanical arts, and a kitchen for teaching the girls cookery, but also a circulating library for the benefit of the whole parish. In furtherance of these objects, we cannot resist giving the following short extract from Sir John Herschel's address: "Of all the amusements which can possibly be imagined for a hard-working man, after his daily toil, or in its intervals, there is nothing like reading an entertaining book, supposing him to have a taste for it, and supposing him to have the book to read. It calls for no bodily exertion, of which he has had enough, or too much. It relieves his home of its dullness and sameness, which, in nine cases out of ten, is what drives him out to the alehouse, to his own ruin and his family's. It transports him into a livelier, and gayer, and more diversified and interesting scene; and, while he enjoys himself there, he may forget the evils of the present moment, fully as much as if he were ever so drunk, with the great advantage of finding himself the next day with his money in his pocket, or, at least, laid out in real ne-

cessaries and comforts for himself and his family,—and without a head-ach. Nay, it accompanies him to his next day's work; and, if the book he has been reading be any thing above the very idlest and lightest, gives him something to think of besides the mere mechanical drudgery of his every-day occupation. —something he can enjoy while absent, and look forward with pleasure to."..."If I were to pray for a taste which should stand me in stead under every variety of circumstances, and be a source of happiness and cheerfulness to me through life, and a shield against its ills, however things might go amiss, and the world frown upon me, it would be a taste for reading."—[Penny Magazine.]

Ingenious Contrivance.—I wish, through the medium of the Centinel and Palladium, to notice a neat and economical improvement made by Mr. Currier, of this city, respecting bells for houses and hotels. Heretofore there have been separate bells for each apartment. These have been numbered to indicate the apartment where an attendant was wanted. In large establishments numerous bells are necessary, and these are costly, and sometimes not useful if the bell had ceased to sound before it was looked at. In the invention *a single bell is sufficient for the largest hotel.* The wire from each apartment, while it rings this common bell, communicates motion to a suspended ball over an appropriate number, and its long continued vibrations give, without fail, and without noise, the information that is desired. The expense is comparatively trifling.—[Boston Centinel.]

On the Burning of Water.—From a recent number of Silliman's Journal, we copy the following respecting the "American Water Burner," which we have several times mentioned. We omit several pages of theoretical reasoning, and confine our extracts entirely to the *results.*

"The experiments which I have made have proved practically, that an engine with a power equal to driving a boat four miles an hour, and a railroad car twice that distance in the same time, with ten or twelve passengers, may be made for one hundred dollars: and that the engine with its preparing vessel (a substitute for the boiler in the steam engine) need not weigh one hundred pounds—and the expense of working it will not exceed ten or twelve cents per hour. There are certainly no difficulties to be removed. These facts have been verified practically and repeatedly before hundreds of people.

"Some recent improvements in the mode of constructing lamps for burning water, to produce light and heat, have perfected the operation for these purposes. It now carries demonstration in every form. For instance, when you put by one fourth of a gill of spirits of turpentine into the lamp, and as much water, and raise the temperature to less than that of boiling water, the vapor that comes over will be in the ratio of about equal parts of each. If, in the combustion of these vapors, a due proportion of air is mixed and inflamed, it will in a few minutes boil a two quart copper tea kettle. If small brass wire is brought over and in contact with the flame, it instantly drops in pieces—small copper wire is readily melted—fine iron wire, if the proportion be right, is instantly inflamed—and thin sheet copper, with a small piece of silver, or silver soldered on it with borax, being exposed to the same, the silver melts in a few seconds, and the copper very soon; and this is done while the vapor is not concentrated in any way, and issues only with a velocity about the same as that of gas in gas lights.

"This discovery gives every promise of supplying a much cheaper fuel, (as a fuel,) exclusive of a clear saving of light, than any one now in use. It is my intention to introduce my lamps, &c. into use as soon as I conveniently can."

The following remarks by Professor Silliman will show how much importance may be attached to these discoveries:

"We have seen some of Mr. Morey's experiments, and can testify to the correctness of his statements, as regards the great amount of heat and light evolved by combustion of the vapor of water mixed with that of spirits of turpentine, or alcohol, and duly modified by common air. The results are very striking and beautiful, and we can see no reason why they should not prove of *great practical utility.*"

Awful Calculation.—An ingenious, authentic, and valuable statistical work, published a few years since, states that the number of inhabitants who have lived on the earth amount to about 36,627,843,275,846. The sum, the writer says, when divided by 3,096,000, the number of square leagues of land on this surface of the globe, leaves 11,820,698,732 persons to each square league. There are 27,864,000 square miles of land, which, being divided as above, gives about 1,314,522,076 persons to each square mile. Let the mile be reduced to square rods, and the number he says will be 1,853,500,000, which, being divided as above, gives 1,283 inhabitants to each square rod, which rod, being reduced to feet and divided as above, will give about five persons to each square foot of terra firma on the globe. Let the earth be supposed to be one vast burying ground, and, according to the above statement, there will be 1,288 persons to be buried on each square rod, capable of being divided into twelve graves: it appears that each grave contained 100 persons, and the whole earth has been one hundred times dug over to bury its inhabitants—supposing they had been equally distributed! What an awful, overwhelming thought! What a lesson to the infatuated being who has centered all his hopes and affections upon the evanescent pleasures of this truly transitory life!

THE FIRE OF ADVERSITY.—It was related of the celebrated Dr. Spurzheim, who died in Boston about a year ago, that, in selecting a lady for a wife, he made choice of one who had seen much trouble and had passed through uncommon scenes of calamity. His theory was, that great mental suffering was necessary in the formation of human character, to develope the highest and purest qualities of the soul.

We need not say how well this corresponds with the sacred declaration—"Every son whom he loveth therefore he chasteneth."

It is hard to heave the sigh, to shed the midnight tear, to feel sorrow passing heavily on the naked heart, and such sorrow, too, as we dare not suffer any one but God to look upon; it is hard and bitter, yet, under its chastening influence, it is not for us to say how much the heart beautifies, and the will acquires, the principles of obedience.

Laying aside the considerations of religious improvement, we often see the soul aroused to a strong energy, to the exertion of unwonted power, by the pressure of some kind affliction.

How many deathless works of genius have been forced into being by the iron hand of poverty. Debts, embarrassments, and want, have been the uncongenial, yet creative elements of poetry and romance. The sweetest songs of the swan are fabled to be exported by the agonies of death.

Let the sufferer who struggles under strange and dreadful dispensations—she who mourns a drunken husband—or he who mourns the solace of his heart immured in an untimely grave—reflect, that affliction only darkens this world that it may brighten the next.

ACTION OF HEAT UPON RAZORS.—It has been asked why, in time of frost, a razor, unless it be warmed, will not cut without irritating the skin? It is because, when it freezes, the edge of a razor, examined by a microscope, is like a saw, and, as soon as warmed, becomes smooth.

ANALYSIS OF OYSTER SHELLS.—One hundred grains of oyster shell will give Carbonate of Lime, 95.18; Phosphate of Lime, 1.88; Silex, 0.40; Water, 1.62; Insoluble animal matter, 0.45; Loss, &c. 0.46. From this view of the composition of recent oyster shell, it is obvious that no appreciable advantage can be expected in applying it as a manure from the minute proportion of animal matter which it has been shown to contain. It is as a carbonate of lime, and that nearly in a state of purity, that it should claim the attention of the agriculturist.—[Farmers' Register.]

METEOROLOGICAL RECORD, KEPT AT AVOYLLE FERRY, RED RIVER, LOU.

For the month of March, 1834—(Lat. 31.10 N., Long. 91.59 W. nearly.)

Date.	*Thermometer.*			*Wind.*	*Weather, Remarks, &c.*
1834.	Morn'g.	Noon.	Night.		
March 1	37	63	60	W—light	clear—light white frost—Red River rising, below high water 5 ft. 6 in.
" 2	45	58	51	N	"
" 3	41	57	51	N—light	"
" 4	36	74	58	"	cloudy—white frost—rain at night
" 5	54	66	64	calm	" morning—evening and night clear
" 6	60	73	70	S—light	" all day
" 7	68	75	74	S—high	" " —at night heavy rain and thunder
" 8	60	71	55	calm	" " —evening and night heavy and steady rain
" 9	48	48	46	N E	" " " " "
" 10	46	48	49	N E light	" " " " light and drizzling "
" 11	50	56	55	calm	" —drizzling all day and night
" 12	54	63	62	"	" " " "
" 13	59	61	60	"	" —heavy thunder and rain all day—night foggy
" 14	59	61	67	"	" —evening thick clouds, and the sun visible through them
" 15	54	73	68	"	clear all day
" 16	58	74	71	S W	cloudy "
" 17	64	67	65	calm	" —rain
" 18	64	74	70	"	" —evening clear
" 19	64	72	71	S E—light	" —and showers all day
" 20	65	70	65	W	clear all day
" 21	50	65	60	N	" "
" 22	47	64	58	calm	" "
" 23	52	67	66	S	cloudy all day—night clear
" 24	60	74	71	calm	" —rain and heavy thunder showers—night clear
" 25	69	80	72	S W	" —night wind severe, W—planted *Beda* grass and *Gama* grass seed
" 26	54	66	64	calm	" —planted second lot of Irish potatoes and sweet potatoes
" 27	61	66	68	"	" — " field of corn, peas, beans, and sowed grass seeds—heavy [rain and thunder
" 28	64	70	63	"	" —rain, and heavy thunder showers
" 29	63	76	72	"	clear all day
" 30	57	78	71	"	" "
" 31	64	79	73	S—high	cloudy morning—clear day

Red River rose this month 2 feet 9 inches—below high water, 2 feet 9 inches.

THE *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. MINOR and J. E. CHALLIS, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*.—JOHN KNIGHT, (formerly proprietor of the London Mechanics' Magazine,) Editor

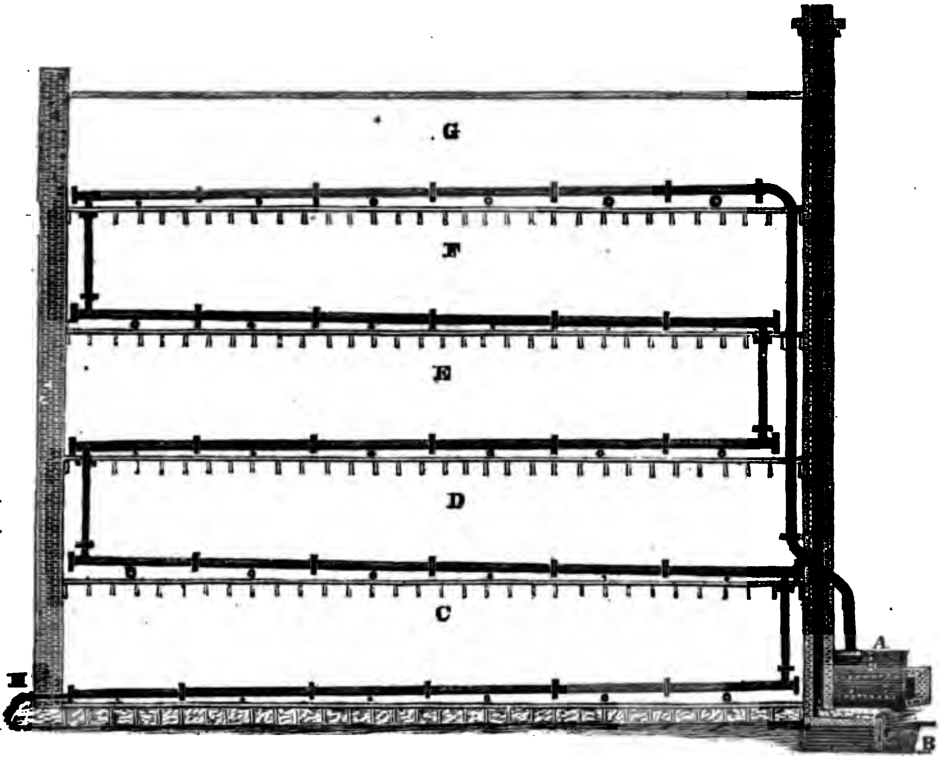
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FOR THE WEEK ENDING MAY 17, 1834. [NUMBER 5.

" He who conceals a useful truth is equally guilty with the propagator of an injurious untruth."—AUGUSTINE.



Effectual Plan of Heating Factories, &c., by Steam. Communicated by the INVENTOR. To the Editor of the Mechanics' Magazine and Register of Inventions, &c.

[We have much pleasure in inserting the following communication from Mr. SNODGRASS, an eminent engineer of Glasgow, N. Britain, now on a visit to the United States for the purpose of ascertaining the state of manufactures and mechanical inventions here. We hope to be favored with other contributions during his tour through various parts of the country, which, we are persuaded, will be highly interesting to our readers.—ED. M. M.]

SIR,—Having perused your interesting and valuable Magazine, I beg leave to avail myself of the pleasure of contributing in a small degree what appears to me would materially benefit the rising manufactories of this justly far-famed free country, namely, the best plan of heating by steam. Although I am almost a stranger here, I learn there are, and have seen, a number of beautiful factories heated by stoves, while in Great Britain there are none, to my knowledge, otherwise than by steam. It must be evident that this method is incompatible with the American atmosphere, which in particular seasons of the year, I am told, is highly electrical, and destitute of hydrogen. Stove heat must accelerate this evil in a considerable degree, in the apartments of the factories, which are

injurious to the staple of the cotton, during the process of roving and spinning, unhealthful to the workers, and a great increase of risk of accident from firing the building.

Having invented and introduced the system of heating by steam pipes, from 1799 to 1807, (see Philosophical Transactions, London, Vol. for March, 1807,) and since then having 27 years' experience, I presume to send you herewith a plain sketch of the simplest and most effectual plan of heating any regular built factory, and with steam of the lowest temperature. REFERENCES—A, the boiler; B, the ash-hole; C, 1st flat; D, 2d flat; E, 3d flat; F, 4th flat; G, garret flat; H, condensed water pipe.

On looking at the plan from right to left, the pipes are inclined according to the length of the factory, so as the air and condensed water may freely recede before the steam, then descend by the perpendicular pipe to next flat, and so on from flat to flat, after sending the steam to the garret flat in the first instance by a large upright, not less than eight or nine inches in diameter, thus allowing as little condensation as possible taking place in that pipe; it ought to be secured from the external air, and made as a reservoir of steam to the boiler. As each range of pipes descends from the garret flat, they ought to increase in diameter about a half inch in each flat, owing to the latent heat of the steam diminishing as the distance increases from the boiler. The small copper pipe at the end of the cast iron range of pipes in the lowest flat, for the discharge of air and condensed water, may be about three-fourths of an inch in diameter. These pipes should be laid on small rollers, pivots of which to move in a small frame (cast iron) fixed on the floors, and close to the washboard of the apartment, on any side most convenient for passing them, thus, not almost, appearing in the room, and, in the lowest position, more effectually heating the air.

The data for proportioning the diameter of these pipes to the temperature of the air in the apartments is a square foot of surface of steam pipe for 200 cubic feet of air, to produce about 64 degrees of heat, supposing the steam about 4 lbs. on the square inch of pressure above the atmosphere, and the surface of the pipes black,—160 superficial inches steam pipe for 72 degrees of heat.

I may add: the boiler may be so placed that the condensed water may be returned to the bottom, and save in a small degree the latent heat therein. Where steam engines are employed to drive the machinery, the surplus steam for a great part of the year is sufficient to heat the factory, thus saving the whole expense of fuel nearly. Insurance ought not to be more than the half, compared with the risk of stoves. If any further information is found wanting, your taking the trouble of addressing me, care of Messrs. Thomson & MacFarlane, No. 87 Pearl street, will be duly attended to by,

Sir, yours, most respectfully,

NEIL SNODGRASS,
Civil Engineer, of Glasgow.

New-York, May 5, 1834.

N. B.—In irregular built factories, much is to be attended to in the arrangement of steam apparatus, for the proper charging with steam, and discharging air and water; also, the best plan for joining the pipes to make them permanent and cheap, which I shall be glad to engineer, and insure the result; also, my metallic packings for steam engine pistons, and piston valves, a drawing and description of which shall be handed you in a short time. N. S.

Wedge Wheels—Indian Arts and Manufactures. By JOHN ROBISON. [From the London Mechanics' Magazine.]

SIR,—In the Mechanics' Magazine for April there is an article entitled "Hancock's Wedge Wheels," in which, although no direct claim of novelty of invention is made by your correspondent, most readers will be led to infer that the construction of the wheel is new, and the invention of Mr. Hancock. I beg, therefore, to state that as far back as the year 1811, I had wheels with the spokes and naves of the same identical construction, made at Hyderabad, for some artillery carriages. I had a pair made at the same time for a curricle, in which the nave was fixed on the axle by double nuts and an oil-tight cup, like Collinge's patent. In the putting together of these wheels, I used a precaution which appears to have escaped your correspondent. I made the butts of the spokes a little too full to admit of their touching the metal box, leaving a vacuity of near an eighth of an inch between them; a corresponding opening was left at the joints of the felloes, and the consequence was that on the tire hoop being put on, its contraction forced the spokes home to the box, and wedged them so hard together at the shoulder, that, even in the hot climate of India, I never observed a spoke become loose by shrinking; it need hardly be said, that the bolt-holes in the butts of the spokes require to be made of an oval form, to admit of the contraction taking place without bending the bolts. My naves were of gun-metal, and I

found it better to have the holes of the inner flanch tapped, than to have nuts on the bolts.

A construction very analogous to this has long been in use in the Madras Artillery, in which service I have always understood that it gave every satisfaction. I once witnessed a striking proof of its good qualities, in seeing a field-piece upset in the course of a charge over some rocky ground, and dragged some yards on its back, until it again righted, without any thing appearing to have given way; in such cases, when the wheel fails, the butts are all left firmly seated in their place, and the spokes break off near to the edges of the flanges.

I observe you have an Indian correspondent, who occasionally gives you descriptions of tools and practices in use among the native workmen. He has omitted to notice one which may be made useful in this country: the saw of an Indian workman always cuts in the pull, and not in the push; by this means a thin bladed saw may be made to do the work of a strong one, as no application of strength in pulling will cause it to buckle. If small saws, such as key-hole saws, were formed to cut by the pull, they would not be so liable to break as they are at present; and if saws for pruning fruit trees were so made, they might be fixed to the ends of long poles and worked from the ground, without requiring the use of a ladder. The common hand-saw in India is from 14 to 18 inches long, with a handle like that of a duelling pistol.

If you have the means of communicating with your Bombay correspondent, you should ask him to get you an account of the processes followed by the lapidaries of the north-west of India, where they make cups and other things of agates, at so cheap a rate, and yet so much cut, that they must have some expeditious methods which may be useful here if known.

I am, sir, your very obedient servant,

JOHN ROBISON.

9 Atholl Crescent, Edinburgh, March 14, 1834.

History of Chemistry. [Continued from page 216.]

OF TIN.—This is one of the metals which was earliest known, and of which the discovery must have been among the first which was made by men; at least, its discovery appears to be hidden in the darkness of ancient times, even beyond those of fabulous history. The Egyptians made great use of it in their arts, and the Greeks alloyed it with other metals. Pliny, without composing an accurate history, or precisely comparing its qualities with other metals, speaks of it as a metal well known, and much employed in the arts, and even applied to a great number of the ornaments of luxury. He often calls it white lead, and points out its frequent and fraudulent contamination with black lead, or lead properly so called.

The alchemists attended greatly to tin; they named it Jupiter, and have distinguished its various preparations by the name of Jovial.

Pure tin is of a white color, equal in beauty and brilliancy to that of silver; and if this color were not changeable, it would be as valuable as silver. It was formerly considered as the lightest of metals, when a distinct and particular class was made of the semi-metals. Its specific gravity varies from 7·291 to 7·500, according as it is hammered or not.

It is one of the softest of metals. It may be easily scratched with the nail; and there is scarcely any other metal which cannot injure its surface by pressure or by friction. A knife readily cuts it; it may be easily bended, and when bended affords a peculiar crackling noise. In this property it has been compared to zinc, but the noise is very different, or much weaker in zinc than in tin.

This phenomenon appears to depend on a separation of its parts, and the sudden fracture which they suffer by the bending, though tin is not easily broken. Its sonorous quality is feeble; its ductility is sufficient to admit of its being reduced by the hammer, or laminating cylinder, into very thin leaves, which are of great use in the arts. It holds the fifth rank among metals in this property. It has little elasticity or tenacity; a wire of this metal of one-tenth of an inch in diameter supports, without breaking, a weight of fifty pounds.

Tin is one of the most dilatable of metals by caloric, according to the experiments of Muschenbroeck.

It is also a good conductor of heat. After mercury, it is the most fusible of all the metals. It comes immediately before bismuth and lead in this respect; its melting point is 440° of Fahrenheit's scale. When fused it does not rise in vapor but at a very elevated temperature; it has ever been considered as one the most fixed of metals; on which account the alchemists thought it considerably resembled silver. If it be suffered to cool slowly, and when its surface is congealed it be pierced, and the part which is still fluid be carefully poured out, the interior presents crystals in rhombs of considerable size, formed by the assemblage of a great number of small needles longitudinally united.

Tin is a very good conductor of electrici-

ty and galvanism, and is frequently used for covering conductors, and for Leyden bottles. It has a very remarkable odor, with which it impregnates the hands and bodies rubbed with it. Its taste is also very sensible, and it also possesses very powerful medicinal properties.

Tin is not very abundant in the bowels of the earth, at least in Europe. The most abundant mines are in Cornwall, Bohemia, and Saxony. The most skilful mineralogists have hitherto distinguished only three species of tin ores: namely, native tin, its oxide, and its sulphuretted oxide.

Tin is not easily oxidized in the air without heat, but it soon loses its bright and beautiful white color. When cut, it is as brilliant and as clear as silver; but in a few hours this fine color changes, becomes dull, and in a few days becomes tarnished. Long exposure to the air considerably increases this alteration, though it takes place only at the surface, so that at last it becomes of a dirty grey, without any brilliancy, and is covered with a light stratum of grey oxide. It is, therefore, necessary that vessels of tin should be frequently cleaned and brightened to renew their surface and retain their beauty. But this weak oxidation never penetrates so deeply as to justify the assertion that tin, like other metals, rusts in the air. When tin is fused with the contact of the air, the metal, when scarcely liquified, becomes covered with a dull grey pellicle, which becomes wrinkled, and separates from the portion of fused tin. When this pellicle is detached, another is formed; and by proceeding in the same manner, the whole of the tin may be converted into pellicles.

In the art of casting and purifying tin vessels, this oxidized matter formed at the surface of the metal in fusion was called dross; and it is very evident that it is in the power of the founder to convert all the tin into dross; he consequently did not lose this pretended impurity, but knew very well how to recover it again in its metallic form, by heating it with tallow or resin. This crust is therefore a true grey oxide of tin; the metal contains from eight to ten per cent. of oxygen, and it is easily reduced. If tin be continually heated with the contact of air, particularly with agitation, it becomes divided, attenuated, and is changed into a powder, which gradually becomes white, with increase of weight, is more oxidized, and constitutes what is called putty of tin in the arts.

Of Lead. — The Alchemists compared lead to Saturn, not only because they suppose this metal to be the oldest, and, as it were, the father of all the others, but also because it was considered as very cold, and possessing the property of absorbing and apparently destroying almost all the other metals; in the same manner as fabulous history affirms that Saturn, the father of the gods, devoured his children.

Lead is of a blueish white color, and when newly melted is very bright, but it soon becomes tarnished by exposure to the air. It has scarcely any taste, but emits on friction a peculiar smell. It stains paper, or the fingers, of a blueish color. When taken internally it acts as a poison.

Its specific gravity is 11·3523, but it is not increased by hammering; so far from it, that Muschenbroeck found lead when drawn out into a wire, or long hammered, to be diminished in its specific gravity. A specimen, at first of the specific gravity 11·479, being drawn out into a fine wire, was of the specific gravity 11·317; and on being hammered it became 11·2187; yet its tenacity was nearly tripled.

It is very malleable, and may be reduced to very thin plates by the hammer; it may be also drawn out into a wire, but its ductility is not great. Its tenacity is such that a lead wire, one-tenth of an inch in diameter, is capable of supporting only 29¼ pounds without breaking.

Lead is a very good conductor of caloric, though it is not extremely dilatable. It melts at a low heat, and immediately after mercury, tin, and bismuth; it holds the fourth rank in the order of fusibility. Mr. Crichton, of Glasgow, estimates it at 612 degrees of Fahrenheit's thermometer. When it is kept long red hot, it sublimes, and emits fumes in the air; but for this purpose a very elevated temperature is required. If it be slowly cooled, it crystalizes in quadrangular pyramids, all formed, as it would appear, of octahedrons. Thus it was that Mongez, the younger, obtained it. It is observable that when this operation is performed, it succeeds best (as tin likewise does) when the lead has been fused several times successively.

This metal is a conductor of electricity and galvanism; but it appears that it possesses these properties only in a weak degree. It has a particular and rather fetid smell; its taste is also somewhat acrid and disagreeable; in consequence of this property it would seem that it acts upon the animal economy, and produces the deadening and paralyzing action which is so well known.

The ores of lead are very abundant in nature, particularly in France, Germany, England, &c. It is also a metal of which the ores are the most varied.

The treatment of the ores of lead in the large way is one of the most important of metallurgical operations, and one of those which have the greatest as well as the most intimate connection with the knowledge and accurate processes of Chemistry. The sulphurous ores containing silver are wrought by pounding them in a stamping engine, and carefully washing them on platforms, and then carrying them to the blast-furnace, where they are first roasted by a gentle heat and afterwards fused by increase of temperature. The fused lead is drawn off from the furnace by opening a hole on one of the sides of its hearth, which, during the fusion, is kept closed with loam. The lead is first cast into pigs, which are called work-lead, because it is intended to be used in subsequent operations to separate the silver which it contains.

Lead exposed to the air becomes speedily tarnished, soon loses the slight brilliancy which characterizes it, becomes of a dirty grey color, and afterwards of a light grey, which constitutes a true rust at its surface.

When thin plates of lead are exposed to the vapor of warm vinegar, they are gradually corroded, and converted into a heavy white powder, used as a paint, and called *white lead*. This powder was formerly considered to be a peculiar oxide of lead, but it is now known that it is a compound of the yellow oxide and carbonic acid.

The grey oxide of lead, when strongly heated for a considerable time in contact with the air, soon becomes yellow by a new absorption of oxygen. In this state of yellow oxide it is called *massicot* in the arts; it appears that it contains from six to nine parts of oxygen in the hundred. It is distinguished into two kinds in commerce on account of its color: the one is called *white massicot*, and the other *yellow massicot*. It is a pigment of a dull hue, without any beauty; sometimes inclining to green, which nevertheless is prepared in the large way in certain manufactories, on account of the uses to which it is applied in the arts. The method of producing it consists simply in perpetually agitating the lead in contact with the air, without using a violent heat.

If massicot, ground to a fine powder, be put into a furnace, and constantly stirred while the flame of the burning coals plays against its surface, in about 48 hours it is converted into a beautiful red powder, known by the name of *minium*, or *red lead*. This powder, which is likewise used as a paint, and for various other purposes, is the *tritoxide*, or *red oxide of lead*.

Lead and tin may be combined in any proportion by fusion. This alloy is harder and possesses much more tenacity than tin. Muschenbroeck informs us that these qualities are a maximum when the alloy is composed of three parts of tin and one of lead. The increased hardness seems to prevent in a great measure the noxious qualities of the lead from becoming sensible when food is dressed in vessels of this mixture. What is called *ley pewter* in this country is often scarcely any thing else than this alloy.* *Tinfoil* is also a compound of tin and lead.

Of Nickel.—Hierne was the first person who mentioned the particular ore which contains nickel, in a work on the art of discovering metals, published in 1694. The ore was named kupfernickel by the Germans, which signifies false copper. Henckel considered it as a species of cobalt, or arsenic, mixed with copper. Cramer referred it also to the copper and arsenical ores, though he did not obtain copper from it, which is also confessed by Henckel.

In its highest state of purity it is of a yellowish or reddish white, of variable brilliancy and granulated texture. This texture is lamellated only in the case of impurity.

Its specific gravity, according to Richter, after being melted, is 8·279; but when hammered it becomes 8·666.

It is malleable both cold and hot, and may without difficulty be hammered out into plates not exceeding the hundredth part of an inch in thickness.

It is attracted by the magnet at least as strongly as iron. Like that metal it may be converted into a magnet, and in that state points to the north, when freely suspended, in the same manner as a common magnetic needle.

There are three ores of nickel, very distinct and very easy to be distinguished; these are the sulphuret of nickel, ferruginous nickel, and native oxide of nickel.

Rinman also affirms that nickel has been found a native of Hesse; it is heavy, of a deep red, forming a kind of product of the furnaces among the materials from which nickel may be extracted. It is considered as an alloy of cobalt and bismuth by the medium of nickel. Nickel is very difficult to be oxidized by the action of caloric and of the air. When it is heated under a muffle, and constantly agitated, it only assumes a dark color. However, by long exposure to moist and cold air, it becomes covered

* There are three kinds of pewter in common use in this country, namely, plate, trifle, and ley. The plate pewter is used for plates and dishes; the trifle chiefly for pint and quart pots; and the ley metal for wine measures, &c. Their specific gravities are as follows: plate, 7·248; trifle, 7·359; ley, 7·963.

with an efflorescence of a clear green color, of a very particular and distinct tinge. It is this efflorescence which is found upon the surface of the sulphurous ores of nickel, the tinge of which being very remarkable, and very different from that of copper, enables us to distinguish them with ease and certainty.

The alloys of this metal are but very imperfectly known.

Mr. Hatchett melted a mixture of 11 parts gold and one nickel, and obtained an alloy of the color of fine brass. It was brittle, and broke with a coarse-grained earthy fracture. The specific gravity of the gold was 19·172; of the nickel 7·8; that of the alloy 17·068. The bulk of the metals before fusion was 2792, after fusion 2812; hence they suffered an expansion. Had their bulk before fusion been 1000, after fusion it would have become 1007. When the proportion of nickel is diminished, and copper substituted for it, the brittleness of the alloy gradually diminishes, and its color approaches to that of gold. The expansion, as was to be expected, increases with the proportion of copper introduced.

Nickel has hitherto been applied to little or no use. It cannot, however, be doubted, that it may be employed with great advantage in the manufacture of enamels, glass, porcelain, and pottery. It is even probable, that it may be an ingredient in the secret processes of some manufactures, as large portions of it are frequently found with the druggists of Paris, who procure it from Saxony only in proportion to the demand which is made for it.

Of Cadmium.—Cadmium was first discovered by M. Stromeyer, in the autumn of 1817, in carbonate of zinc, which he was examining in Hanover. It has been since found in the Derbyshire silicates of zinc. The following is Dr. Wollaston's process of procuring cadmium. From the solution of the salt of zinc supposed to contain cadmium, precipitate all the other metallic impurities by iron; filter and immerse a cylinder of zinc into the clear solution. If cadmium be present it will be thrown down in the metallic state, and when re-dissolved in muriatic acid will exhibit its peculiar character on the application of the proper tests. The color of cadmium is a fine white, with a slight shade of blueish grey, approaching much to that of tin, which it resembles in lustre and susceptibility of polish. Its texture is compact, and its fracture hackly. It crystalizes easily in octahedrons, and presents on its surface, when cooling, the appearance of leaves of fern. It is flexible, and yields readily to the knife. It is harder and more tenacious than tin; and, like it, stains paper, or the fingers. It is ductile and malleable, but when long hammered it scales off in different places. Its specific gravity, before hammering, is 8·6, and when hammered it is 8.69. It melts and is volatilized under a red heat. Its vapor, which has no smell, may be condensed in drops like mercury, which, on congealing, present distinct traces of crystalization.

Cadmium is as little altered by exposure to the air as tin. When heated in the open air it burns like that metal, passing into a smoke which falls and forms a very fixed oxide, of a brownish yellow color. Nitric acid readily dissolves it cold; diluted sulphuric, muriatic, and even acetic acids, act feebly on it with the disengagement of hydrogen. The solutions are colorless, and are not precipitated by water.

Cadmium unites easily with most of the metals, when heated along with them and the air excluded; but most of its alloys are brittle, and without color. That of copper and cadmium is white, with a slight tinge of yellow. Its texture is composed of very fine plates. A very small portion of cadmium communicates a good deal of brittleness to copper; but at a strong heat cadmium flies off.

Cadmium unites with several other metals, particularly with cobalt, platinum, and mercury. With the last metal it forms an amalgam, the specific gravity of which exceeds that of mercury itself.

Of Zinc.—It is believed that zinc was not known to the ancients. Paracelsus is the first chemist who has treated of it, and who gave it the name which it bears. Agricola has since termed it *contre-feyne*, and Boyle, *speltrum*. Albertus Magnus, who died in the year 1280, makes very distinct mention of it; he knew that it was combustible and inflammable, and that it colored metals. It appears that zinc has for a long period back been extracted from its ores in the East Indies, as was first discovered by Jungius, in the year 1647. It was brought from those parts under the name of *tutenague*. Without being particularly acquainted with it, and distinguishing it accurately from other metals, the Greeks seem also to have employed it, as it is said to have constituted a part of the famous Corinthian brass.

It is not known by what process the Chinese obtain this metal, which they employ in a great number of alloys; it is, however, believed that they extract it by distillation. Henckel asserted, in 1721, in his Pyritolo-

gia, that zinc might be extracted from calamine.

Zinc is of a brilliant white color, with a shade of blue, and is composed of a number of thin plates adhering together. When this metal is rubbed for some time between the fingers, they acquire a peculiar taste, and emit a very perceptible smell. When rubbed upon the fingers, it tinges them of a black color. The specific gravity of melted zinc varies from 6·861 to 7·1; the lightest being esteemed the purest. When hammered, it becomes as high as 7·1908.

This metal forms, as it were, the limit between the brittle and the malleable metals. When struck with a hammer it does not break, but yields, and becomes somewhat flatter; and by a cautious and equal pressure, it may be reduced to pretty thin plates, which are supple and elastic, but cannot be folded without breaking. This property of zinc was first ascertained by Mr. Sage. When heated somewhat above 212° it becomes very malleable. It may be beat at pleasure without breaking, and hammered out into thin plates. When carefully annealed it may be passed through rollers. It may also be very readily turned on the lathe. When heated to about 400° it becomes so brittle that it may be reduced to powder in a mortar.

It possesses a certain degree of ductility, and may with care be drawn out into wire. Its tenacity, from the experiments of Muschenbroeck, is such that a wire, whose diameter is equal to one-tenth of an inch, is capable of supporting a weight of about 26 pounds.

When heated to the temperature of about 680° it melts; and if the heat be increased it evaporates, and may be easily distilled over in close vessels. When allowed to cool slowly it crystalizes in small bundles of quadrangular prisms, disposed in all directions. If they are exposed to the air whilst hot, they assume a blue changeable color.

Zinc is applied to uses no less numerous than important in many of the arts. It forms a part of a number of hard and white alloys. It is particularly employed in the fabrication of tombac and brass. The eastern nations, and especially the Chinese, make use of it, as has already been observed, much more frequently than the Europeans; perhaps because they possess it in greater abundance than we do, and perhaps because they are better acquainted with its useful properties.

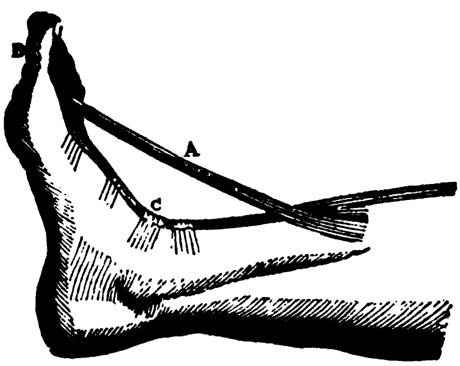
Zinc and its chemical preparations have already been applied to medicinal purposes. Its property of conducting so great a degree of galvanism may hereafter render it much more valuable to the healing art.

Animal Mechanics, or Proofs of Design in the Animal Frame. [From the Library of Useful Knowledge.]

(Continued from page 221.)

We may perceive the same effect to result from the course of the tendons, and their confinement in sheaths, strengthened by cross straps of ligament. If the tendon, A, (fig. 27) took the shortest course to its ter-

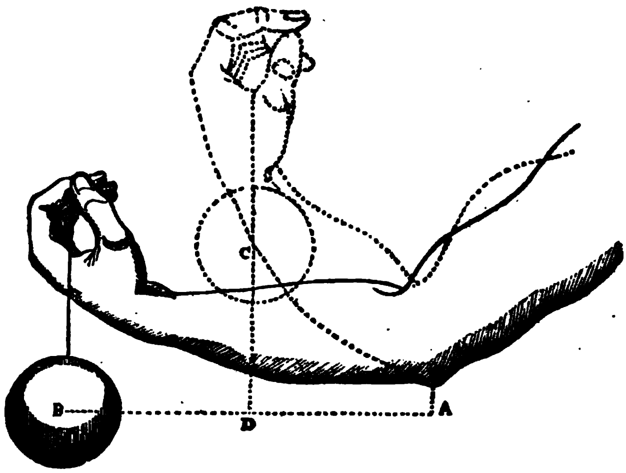
Fig. 27.



mination at B, it would draw up the toe with greater force; but then the toe would lose its velocity of movement. By taking the direction, C, close to the joints, the velocity of motion is secured, and by this arrangement the toes possess their spring, and the fingers their lively movements. We may take this opportunity of noticing how the mechanical opposition is diminished as the living muscular power is exhausted. For example, in lifting a weight, the length of the lever of resistance will be from the centre of the elbow joint, A, (see engraving on the following page, fig. 28,) to the centre of the weight B. As the muscles of the arm contract, they lose something of their power; but in a greater proportion is the mechanical resistance diminished, for when the weight is raised to C A D, it becomes the measure of the lever of resistance.

A more admirable thing is witnessed by the anatomist—we mean the manner in which the lever, rising or falling, is carried beyond the sphere of action of one class of muscles, and enters the sphere of activity of others. And this adaptation of the organs of motion is finely adjusted to the mechanical resistance which may arise from the form or motion of the bones. In short, whether we contemplate the million of fibres which constitute one muscle, or the many muscles which combine to the movement

Fig. 28.



of the limb, nothing is more surprising and admirable than the adjustment of their power so as to balance mechanical resistance, arising from the change of position of the levers.

In the animal body there is a perfect relation preserved betwixt the parts of the same organ. The muscular fibres forming what is termed the belly of the muscle, and the tendon through which the muscle pulls, are two parts of one organ; and the condition of the tendon indicates the state of the muscle. Thus jockeys discover the qualities of a horse by its sinews or tendons. The most approved form in the leg of the hunter, or hackney, is that in which three convexities can be distinguished,—the bone, the prominence of the elastic ligament behind the bone, and behind that the flexor tendons, large, round, and strong. Strong tendons are provided for strong muscles, and the size of these indicate the muscular strength. Such muscles, being powerful flexors, cause high and round action, and such horses are safe to ride; their feet are generally preserved good, owing to the pressure they sustain from their high action. But this excellence in a horse will not make him a favorite at Newmarket. The circular motion cannot be the swiftest; a blood horse carries his foot near the ground. The speed of a horse depends on the strength of his loins and hind quarters; and what is required in the fore-legs is strength of the extensor tendons, so that the feet may be well thrown out before, for if these tendons be not strong, the joints will be unable to sustain the weight of his body when powerfully thrown forward, by the exertion of his hind quarters, and he will be apt to come with his nose to the ground.

The whole apparatus of bones and joints being thus originally constituted by Nature in accurate relation to the muscular powers, we have next to observe that this apparatus is preserved perfect by exercise. The tendons, the sheaths in which they run, the cross ligaments by which they are restrained, and the *bursæ mucosæ** which are interposed to diminish friction, can be seen in perfection only when the animal machinery has been kept in full activity. In inflammation and pain, and necessary restraint, they become weak; and even confinement, and want of exercise, without disease, will produce imperfections. Exercise unfolds the muscular system, producing a full bold outline of the limbs, at the same time that the joints are knit, small, and clean. In the loins, thighs, and legs of a dancer, we see the muscular system fully developed; and when we turn our attention to his puny and disproportioned arms we acknowledge the cause—that in the one instance exercise has produced perfection, and that, in the other, the want of it has occasioned deformity. Look to the legs of a poor Irishman travelling to the harvest with bare feet: the thickness and roundness of the calf show that the foot and toes are free to permit the exercise of the muscles of the leg. Look again to the leg of our English peasant, whose foot and ankle are tightly laced in a shoe, with a wooden sole, and you will perceive, from

---

* These *bursæ mucosæ* (mucous purses) are sacks containing a lubricating fluid. They are interposed wherever there is much pressure or friction, and answer all the purposes of friction wheels in machinery.

the manner in which he lifts his legs, that the play of the ankle, foot, and toes, are lost, as much as if he went on stilts, and therefore are his legs small and shapeless.

And this brings us naturally to a subject of some interest at present: we mean the new fashion of exercising our youth in a manner which is to supersede dancing, fencing, boxing, rowing, and cricket, and the natural impulse of youth to activity.

By this fashion of training to what are termed *gymnastics*, children at school are to be urged to feats of strength and activity, not restrained by parental authority, nor left to their own sense of pleasurable exertion. They are made to climb, to throw their limbs over a bar, to press their feet close to their hip, their knees close to their stomach; to hang by the arms and raise the body; to hang by the feet and knees; to struggle against each other by placing the soles of their feet in opposition, and to pull with their hands. No doubt if such exercises be presevered in the muscular powers will be strongly developed. But the first question to be considered is the safety of this practice. We have seen a professor of gymnastics, by such training, acquire great strength and prominence of muscles; but by this unnatural increase of muscular power, through the exercise he recommended, he became ruptured on both sides. The same accident has happened to boys too suddenly put on these efforts.

It is proper to observe, that when the muscular power is thus, we may say preternaturally increased, whether in the instance of a race-horse, an opera-dancer, or a pupil of the Calisthenic school, it is not merely necessary to put them on their exercises gradually in each successive lesson, but each day's exertion must be preceded by a wearisome preparation. In the great schools, like that at Stockholm, the master makes the boys walk in a circle; then run, at first gently; and so he gradually brings them into heat, and the textures of their frame are composed to that state of elasticity and equal resistance, as well as to vital energy, which is necessary for the safe display of the greater feats of strength and activity. This caution in the public exercises is the very demonstration of the dangers of the system. The boys will not be always under this severe control, and yet it is important to their safety.

We may learn how necessary it is to bring the animal system gradually into action from the effects of very moderate exercise on a horse just out of the dealer's hands. The purchaser thinks he may safely drive him ten miles, not aware that the horse has not moved a mile in a week, and the consequence is inflammation and congestion in his lungs. The regulation in the army has been made on a knowledge of these facts. When young horses are brought from the dealer they are ordered to be walked an hour a day the first week, two hours a day the second week, three hours a day in the third week. They are to be fatigued by walking, but they must not be sweated in their exercise. Horses for the turf, under three years old, in training for the Derby, are brought very slowly to their exercise, beginning with the lounge; then a very light weight is put upon them, and that gradually increased. Indeed, nothing can better show the effects of exercise in perfecting the muscular action than the consequence of the loss of one day's training. It will bring the favorite to the bottom of the list, and that without any suspicion of lameness; but from a knowledge of the fact, that even such a slight irregularity in his training will have a sensible effect on his speed. Shall the possibility of pecuniary loss excite the jockey to more care for his horse than we, in our rational and humane attention to the education of our youth, pay to their health and safety?

In reflecting on these many proofs of design in the animal body, it must excite our surprize, that anatomy is so little cultivated by men of science. We crowd to see a piece of machinery, or a new engine, but neglect to raise the covering which would display in the body the most striking proofs of design, surpassing all art in simplicity and effectiveness, and without any thing useless or superfluous.

A more important deduction from the view of the animal structure is, that our conceptions of the perfection and beauty in the design of nature are exactly in proportion to the extent of our capacity. We are familiar with the mechanical powers, and we recognize the principles in the structure of the animal machine; and, in proportion as we understand the principles of hydrostatics and hydraulics, are able to discern the most beautiful adaptation of them in the vessels of an animal body. But when, to our further progress in anatomy, it is necessary that we should study a matter so difficult as the theory of life, imperfect principles or wrong conceptions distort and obscure the appearances: false and presumptuous theories are formed, or we are thrown back in disappointment into scepticism, as if chance only could produce that of which we do not comprehend the perfect arrangement. But studies better directed, and prosecuted in a better spi-

rit, prove that the human body, though deprived of what gave it sense and motion, is still a plan drawn in perfect wisdom.

A man possessed of that humility which is akin to true knowledge, may be depressed by too extensive a survey of the frame of nature. The stupendous changes which the geologist surveys—the incomprehensible magnitude of the heavenly bodies moving in infinite space, bring down his thoughts to a painful sense of his own littleness: "to him, the earth with men upon it will not seem much other than an ant hill, where some ants carry corn, and some carry their young, and some go empty, and all to and fro a little heap of dust."*

He is afraid to think himself an object of Divine care; but when he regards the structure of his own body, he learns to consider space and magnitude as nothing to a Creator. He finds that the living being which he was about to contemn, in comparison with the great system of the universe, exists by the continuance of a power no less admirable than that which rules the heavenly bodies; he sees that there is a revolution, a circle of motions, no less wonderful in his own frame, in the microcosm of man's body, than in the planetary system; that there is not a globule of blood which circulates but possesses attraction as incomprehensible and wonderful as that which retains the planets in their orbits.

The economy of the animal body, as the economy of the universe, is sufficiently known to us to compel us to acknowledge an Almighty Power in the creation. What would be the consequence of a further insight—whether it would conduce to our peace or happiness, whether it would assist us in our duties, or divert us from the performance of them,—is very uncertain.

CHAPTER VII.

Books referring to these Subjects more generally.—Ray, "On the Wisdom of God manifested in the Works of the Creation," has several chapters on the animal economy.

Archdeacon Paley has composed a work of high interest, by taking the common anatomical demonstrations, and presenting them in an elegant and popular form. His work is entitled Natural Theology; or Evidences of the Existence and Attributes of the Deity, collected from the Appearances of Nature.

The celebrated Fenelon has, with the same pious object, composed a small duodecimo, in which he draws his arguments from the structure of animal bodies.

Wollaston, in the "Religion of Nature delineated," has the same train of reflection to prove that there can be no such thing as chance operating in and about what we see or feel; and he says, with great propriety, "How may a man qualify himself so as to be able to judge of the religions professed in the world; to settle his own opinions in disputable matters; and then to enjoy tranquillity of mind, neither disturbing others, nor being disturbed at what passes among them?"

Derham, in sixteen sermons, preached in 1711, at the lecture founded by Mr. Boyle, treats at length of the structure of our organs. These are also published separately under the title of *Physico-Theology;* and they naturally suggest to learned divines the expediency of sometimes expounding to their hearers the evidences of design apparent in the universe, as a sure means of enlightening their understandings, elevating their views, and awakening their piety.

This cultivation of the mind, by exercising it upon the study of proper objects, is a man's first duty to himself. Without it he can have no steady opinion on points of the nearest concern. He is wrought upon by circumstances which ought not to sway the mind of a sensible man; at one time depressed to the depths of despondency, and at another exalted into unreasonable enthusiasm. Without such cultivation, were a man to live a hundred years, he is at last like one cut off in infancy.

PART II.

Showing the Application of the Living Forces.

Amongst the least informed people, and in remote villages, there are old laws and rules regarding health, sickness, and wounds, which might be thought to come from mere experience; but they are, on the contrary, for the most part, the remains of forgotten theories and opinions, laid down by the learned of former days. Portions of knowledge, it would appear, confined at first to a select part of society, are in the progress of time diffused generally, and may be recognized in the aphorisms of the poor. These are traced to their source only by the curious few, who like to read old books, and to observe how that which is originally right, becomes, through prejudice and ignorance, distorted and fantastical.

If a very little exact knowledge of the structure of our own frames were more generally diffused, charity would be advanced,

* Bacon.

empirics could hardly maintain their influence, and medical men might have a further motive to desire professional eminence.

Men suppose that the knowledge of their own bodies must be a science locked up from them, because of the language in which it is conveyed; or they take away their thoughts from it, as from the contemplation of danger, unwilling to survey the slight ties by which they hold their lives. They are like persons for the first time at sea, who shudder to calculate how many circumstances must concur to speed the frail vessel on its voyage, and how little is between them and the deep. It is then a mean and timid spirit that shuts out from our contemplation the finest proofs of Divine Providence. Galen's treatise on the uses of the parts of the human body was composed as a hymn to the Creator, and abounds in demonstrations of a Supreme Cause; and when Cicero desires to prove the existence of the Deity from the order and beauty of the universe, he surveys the body of man, deeming nothing more godlike, as marking man's superiority to the brutes, than the privilege of contemplating his own condition, since it teaches him the ways of Providence, from a knowledge of which come piety and all the virtues.

Although we are writing under the title of Animal Mechanics, the reader must be aware that we cannot proceed much farther on mechanical principles alone. At least, before we have it in our power to illustrate particular parts of the animal frame by reference to those principles, we must have the proofs before us that we are considering a living body. It is the principle of *life* which distinguishes the studies of the physiologist from the other branches of natural knowledge. To lose sight of this distinction is to tread back the path, and to engage once more in the vain endeavor to explain the phenomena of life on mechanical principles. We have taken mechanics in their application to mechanical structure in the living body, because they give obvious proofs of design, and in a manner that admits of no cavil. Yet, although those proofs are very clear in themselves, they are not so well calculated to warm and exalt our sentiments as these which we have now to offer, in taking a wider view of the animal economy.

In entering on the second department of this treatise, the reader may be startled at the subjects of discussion, but this comes also from ignorance of their nature. Much may be learned from the observation of things familiar. Their perpetual recurrence banishes reflection respecting them, but it is the business of philosophy to make us alive to the importance of that which we have been accustomed to from childhood, and have therefore long ceased to observe with attention.

In the first chapter of this second part we shall continue to examine the operations of the animal body, independently of the agency of the living property: we shall consider it as a mere hydraulic machine. Following the blood in its circle through cisterns and conduit pipes, we shall point out the application of the principles of this science, as we formerly did those of mechanics, and so arrive at the like conclusions by a different course. And as we before found every muscular fibre adjusted with mechanical precision, so now we shall find every branch of an artery, or of a vein, taking that precise course and direction which the experience of the engineer shows to be necessary in laying the pipes of an engine.

Having thus surveyed the mechanical operations of the animal body, and the course of the fluids conveyed through it, on hydraulic principles, we shall consider ourselves as having advanced through the meaner to the higher objects of inquiry, and proceed to show how the principle of life bestows different endowments on the frame-work; how motion originates in a manner quite different from that produced by mechanical forces; how the sensibilities animate the living properties of action; how the different endowments of life correspond with each other, and exhibit power and design in a degree far superior to any thing that we observed in the mechanical adjustment of the parts or the circulation of the fluids.

CHAPTER I.

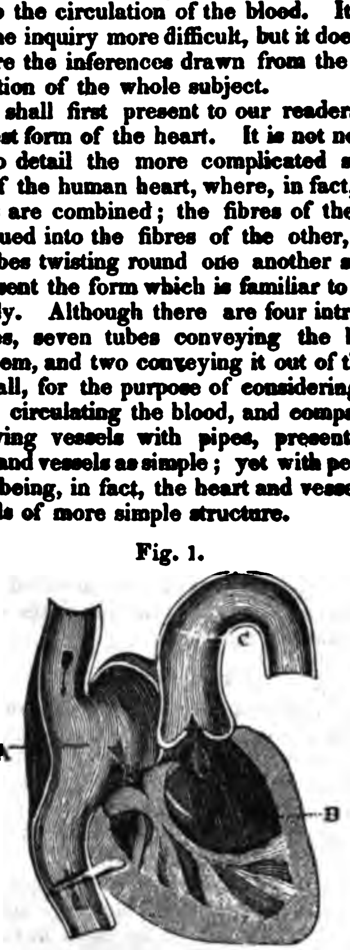
The Circulation of the Blood upon the Principles of Hydraulics.—In tracing the course of the circulation of the blood, it is natural to inquire how far the system of reservoirs, pipes and valves, which form the apparatus for conveying it, are constructed on the principles of hydraulics.

We find this difficulty in the outset, that the vessels containing the blood are not rigid, like those the engineer employs in erecting hydraulic machinery. Instead of resembling pipes which convey water, and which receive the force of gravitation on them, they have both elasticity and an appropriate living power. The artery, the tube which conveys the blood out from the heart to the body, has a property of action in itself. Its elasticity and muscular power must derange those influences which we study in pure hydraulics.

There is to be found, notwithstanding, a great deal that is common to both, when we compare the tubes of an animal body with the hydraulic engine; the capacity of the vessels; the increase or diminution of their calibres; their curves; the direction of their branches—all these ought still to be on the same principles on which experience has taught men to form conduit pipes. We ought not to be indifferent to these proofs of design, because we acknowledge that an infinitely superior power is brought into operation in the animal body, and which is necessary to the circulation of the blood. It renders the inquiry more difficult, but it does not obscure the inferences drawn from the consideration of the whole subject.

We shall first present to our readers the simplest form of the heart. It is not necessary to detail the more complicated structure of the human heart, where, in fact, two hearts are combined; the fibres of the one continued into the fibres of the other, and the tubes twisting round one another so as to present the form which is familiar to every body. Although there are four intricate cavities, seven tubes conveying the blood into them, and two conveying it out of them, we shall, for the purpose of considering the forces circulating the blood, and comparing the living vessels with pipes, present the heart and vessels as simple; yet with perfect truth, being, in fact, the heart and vessels of animals of more simple structure.

Fig. 1.



The action of the heart is this: the blood returns from the body by veins into the sinus, or auricle,* A, and distends it; this sinus is surrounded with muscular fibres; by the distention or elongation of these fibres they are excited, and the sinus contracts and propels the blood into the ventricle B. The ventricle is, more muscular; it is, in fact a powerful hollow muscle; it is excited by the distention, and contracts and propels the blood into the artery, C.

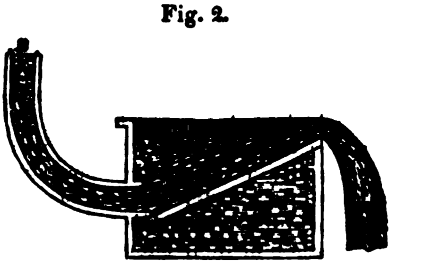
We understand, then, that every heart must, at least, consist of two cavities alternating in their action; that the vessel which carries the blood to them is called a vein; and that the vessel which carries the blood out from them is the artery.

The first thing that strikes a person examining the heart is the extraordinary intricacy of the cavities, from the interlacing of its muscular fibres, and he naturally says that they appear ill calculated for conveying a fluid through them. There is an attraction between fluids and solids, he might observe, and this attraction is increased by the extension of the surfaces of the pillars and cords which he sees in the interior of the heart.

We must remind him that the blood is coming back from the body, having performed very different offices, in different parts, and has parted with different properties in the several organs it has supplied. There is, in that stream of blood which enters through the vein, a new supply of fluid, which has come by digestion, the material for making fresh blood, as well as that which has run the circle. These two fluids must be thoroughly mixed together, and no doubt this is one of the offices provided for by the intricacy of the interior of the heart.

Again, looking to the recesses of the cavities formed between the fleshy columns, and behind the valves, we might suppose that the blood would remain there stagnant. There are cavities, or recesses, too, in the remote parts of the circulating vessels, where we might suspect that the influence of the stream would not be felt, and a stagnation might take place. But there is attraction between the particles of fluids, as well as between the fluids and their containing tubes. Let us see then how, in this figure, a stream of

Fig. 2.



water, carried through a cistern of water, will, by its friction, draw after it the water in

* Auricle, from *auricula*, the flap of the ear, is a name given to the sinus, because a corner of it hangs over like a dog's ear.

the cistern, and carry it above its natural level, and over the side of the vessel.

The stream entering the reservoir, A, by the pipe, B, carries with it all the water, C, which stands above the level of its upper surface. By this we see that the stream of blood entering into the heart, even if its cavities were not emptied at each impulse, as some contend they are, would draw out the blood from its recesses, so that no part could remain stagnant, but, on the contrary, all would be carried in eddies round the irregularities, until they took the direction of the great artery, in which they would be perfecly combined.

The next thing to be noticed partakes of the nature of a mechanical provision—we mean the action of the valves.

We must here remark, that the opening into the ventricle is very different from that which leads out of it, the latter being much smaller. Medical writers describe this as if it were nothing to them, and a mere accident. But it must be recollected that a stream of water entering a reservoir is in a very different condition from that which is going out of it; it is on this principle that the mouths (*ostia* is the anatomical term) of the ventricle are differently formed, and it is this difference which makes the structure of the valves which guard those passages so dissimilar and so appropriate. Without attention to this we should follow our medical authorities, and call this variety in the mechanical adaptation a mere playfulness in nature. It is more agreeable to us to see a precision of design visible at the first step of this inquiry.

The valves of the heart are regular flood-gates, which close the openings against the retrograde motions of the blood. They are not all of the same mechanical construction, and their difference deserves the reader's attention as proving design in this hydraulic machinery.

The valve which we have first to describe closes the opening betwixt the auricle, or sinus, and the ventricle, and prevents the action of the ventricle propelling the blood back again into the auricle.

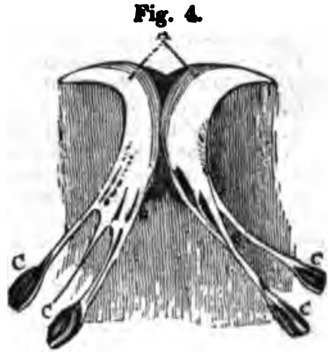
It is a web, or membrane, resembling a sail when bagged by the wind. The blood catches the margin of this membrane, and distends it as the wind does the stay-sail, or gib, of a vessel, which it much resembles, being triangular and pointed. There are three of these membranes, and the valve is called *tricuspid*, or three-pointed. Three membranes, then, of this kind, combining and being floated back upon the mouth of the opening, effectually close it.

The illustration of the action of these valves by a sail is so perfect, that if the reader will have patience to attend to those little contrivances which the mariner finds necessary for strengthening his canvass, and giving to it the full influence of the wind, he will have an accurate idea of the adjustment of these floating valves.

Fig. 3.

To carry on the comparison: one edge of the stay-sail is extended upon the stay, A A, and tied to it by *hanks*. The edges of the sails, called the *leeches*, have a *bolt-rope* run along them; and on the edge where it is attached, the canvass is strengthened by being hemmed down or tabled. In the same way as the foot of the sail, or lower margin, is strengthened with the bolt-rope, just so are the valves strengthened at their edges and their corners. Where the two ropes join in the loose corner of the sail, they form a clue—a loop to which tackle is attached; the valve has such a corner so strengthened, and has a cord attached. The corners of the sail are strengthened by additional portions of canvass called patches; so are the valves strengthened where their tendons are

Fig. 4.



infixed. To the corner or clue, B, ropes are attached which are called the *sheets*, C C. These being drawn tight, spread out

the foot of the sail to one side or the other, according to the direction of the wind, and the tack the ship is on; the valves have also their tackle; and, in short, we shall find a resemblance to all the parts of a sail in the valves of the heart.

One edge of the triangular valve is tied to the margin of the opening, as one of the leeches of the sail is attached to the stay; the opposite corner is loose, and floats, as the sail does in tacking, until the blood, bearing against it as the wind bears against the sail, bags and distends it; the corner is then held down by tendons, for there are cords attached to the corner of the valve, as well as to the corner of the sail. These the anatomists call *cordæ tendineæ*, B B, which in their office have an exact resemblance to the ropes called the sheets of the sail. They are delicate tendons attached to the margin of the valve, and they prevent the margin from being carried back into the auricle.

On the Location of Railroad Curvatures. By Van De Graaff. [From the American Railroad Journal, and Advocate of Internal Improvements.]

(Continued from page 187.)

Although a system of rectangular lines, traced from given co-ordinate axes, will, in general, furnish the best *data* for computation, yet cases sometimes occur when those calculations have to be made either from computed curves, or curves actually laid upon the ground. In a first location this case will sometimes happen, when, from difficulties which are found in advance of a line, it becomes necessary to change a part of that which was either already computed, or actually laid. Such a case will sometimes occur, even when the operations in the field have been skilfully conducted; and in laying curves upon a surface already *graded*, it will be frequently necessary to compute from curves actually traced. The principles contained in the four last articles have been given chiefly with this object in view. But with regard to the two last articles, (7 and 8,) it may be observed, that, *when the curves are long*, it becomes very important to have some method of obtaining the *position* of the line *w* from the extremity of either curve; for a knowledge of only the *length* of that line will, in such a case, be of very little use in the field, unless the direction is also known, in order that the termination of any *proposed* curve may be immediately *pointed out* by an instrument placed at the termination of a given curve. There is no difficulty in obtaining very convenient formulas for the object thus proposed; but for want of room in this journal, I must proceed to other things.

10. *Take a system of rectangular co-ordinate axes, having their origin at a given station in a tangent line, from which a certain required curve is to be laid, passing through a point designated by the co-ordinates* x y; *the given tangent line coinciding with the axis of* x: *and let a system of rectangular lines be traced from the origin to the designated point, agreeably to the method proposed in article* 4. *It is then required to determine a method by means of which the instrument may be immediately directed into the true tangent at the designated point.*

Let the successive rectangular lines, as traced from the origin, be represented by *a b c d*, &c. It may then be observed that the safest method of recording the lines *a b c d*, &c., in the field, will be to take a blank form, $\left\{\begin{matrix} x = \\ y = \end{matrix}\right. \qquad \left.\vphantom{\begin{matrix} x \\ y \end{matrix}}\right\}$, and then record each line in its proper equation, and with its proper *sign*, immediately as their values are determined by measurement.

A matter of considerable importance in the field, after the rectangular lines *a b c*, &c. have been traced to any proposed point, is to be able to examine, by the direction of the instrument, what the direction of the curve would be passing from the origin through that given point. Indeed, in difficult situations, a curve cannot be *selected* without such a datum; and if the rectangular lines *a b c*, &c. were *not sufficient* to furnish that datum with facility, a curve would have to be actually laid upon the ground, in order to judge of its fitness, even if a point were known through which it would pass. It would evidently be not difficult to direct the instrument, when placed at the given point, into the true tangent there, if the inclination of that tangent to the primitive tangent at the origin were known. For the last rectangular line traced will, of course, be either parallel to the primitive tangent, or perpendicular to it; and, in either case, it furnishes the means of directing the instrument into a line parallel to the primitive tangent at the origin. It is then only necessary to deflect an angle equal to the inclination of those two tangents, when that inclination is known, and the direction of the curve at the given point may then be perceived at once, from the position of the instrument, without that delay which would be occasioned by actually tracing a curve upon the ground, which must ultimately be relaid. The result, therefore, is, that a formula must be investigated, expressing the inclination of the two tangents in terms of the given co-ordinates *x y*. Take D to denote the inclination required; then D = 2 *n* T, and consequently, by art. 2,

$$x = \frac{\text{Sin. D}}{2 \sin. \text{T}}, \text{ and } y = \frac{1 - \text{Cos. D}}{2 \sin. \text{T}}.$$

Eliminating D from those two equations, the result is,

$$\text{Cot.} \tfrac{1}{2} \text{D} = \frac{x}{y}.$$

Such is the formula required, and its applications are very extensive in the field: for it will thus be seen, at once, whether or not the given point can be maintained; and this fact should be always ascertained, and the most judicious line definitely *selected*, before any curve is actually traced.

11. It is frequently necessary that several points should be designated, through which a curve is required to pass by means of a change of curvature at each of those points. To show the method of operation which ought to be pursued under such circumstances, take a system of rectangular co-ordinate axes, coinciding with the primitive origin and tangent line. Trace, parallel to those axes, a system of rectangular lines, given by the equations

$$\begin{Bmatrix} x = a + b + c + \text{\&c.} \\ y = d + e + f + \text{\&c.} \end{Bmatrix}$$

and terminating at the *first designated point.* Let the instrument be then placed at that point, and directed into tangent agreeably to the method explained in the last article. Take this second tangent as the axis of x, for a new system of rectangular co-ordinate axes; and parallel to these new axes, trace a second system of rectangular lines, given by the equations.

$$\begin{Bmatrix} x = a' + b' + c' + \text{\&c.} \\ y = d' + e' + f' + \text{\&c.} \end{Bmatrix}$$

and terminating at the *second designated point.* Let the instrument be now placed at this second point, and again directed into the proper tangent by the same means as before. Take this third tangent as the axis of x, for a third system of rectangular co-ordinate axes; and parallel to this second new system of axes, trace a third system of rectangular lines, given by the equations

$$\begin{Bmatrix} x = a'' + b'' + c'' + \text{\&c.} \\ y = d'' + e'' + f'' + \text{\&c.} \end{Bmatrix}$$

and terminating at the *third designated point.* Continue this obvious order of proceeding, until equations

$$\begin{Bmatrix} x = \qquad\qquad \\ y = \qquad\qquad \end{Bmatrix}$$

have been obtained for *all the designated points;* and then by means of those equations, and article 4, compute all the moduli of curvatures. Returning now with the instrument to the primitive origin, let each curve be traced from its proper modulus of curvature, and the line will be found *to pass through all the designated points.* If proper care be observed in chaining the different systems of rectangular lines, by means of which the equations

$$\begin{Bmatrix} x = \qquad\qquad \\ y = \qquad\qquad \end{Bmatrix}$$

have been obtained, there can be no disappointment in the result; and, consequently, if the designated points have been judiciously selected, there will very seldom be a necessity of *tracing* the same part of a line *the second time;* and thus the method of co-ordinate axes, when skilfully conducted, will constitute one of the most important systems of operations connected with the location of railroad lines.

In tracing the various systems of rectangular lines through the different points which may be designated for a curve, there is a principle of practical convenience which must be mentioned. I mean the principle of designating such points *for a change of curvature,* as will cause each section of the whole curve, between the designated points, to be composed of an *integer number of chains,* when those curves come to be ultimately traced, after their respective moduli of curvatures have been ascertained by the methods explained above. It is indeed necessary in every case, except where the road-way is perfectly horizontal, to know the *length* of each of those separate curves, in order to select the designated point correctly with respect to *grade;* and this datum must therefore always accompany the levels. When a system of those rectangular lines have been traced to any given point, and the resulting equations

$$\begin{Bmatrix} x = \\ y = \end{Bmatrix}$$

have been thus obtained, the distance from the origin to that given point, in a right line, will obviously be truly expressed by $\sqrt{x^2+y^2}$; which is a formula rendered very convenient for use, by means of a table of the squares and square roots of numbers. And this quantity may be frequently taken as the length of the intervening curve, by which to compute what the *grade* would be at that given point, and will always furnish an easy method of obtaining the approximate distance necessary in making a selection for the *position of a line,* as far as the levels have an influence. The next object, then, must be finally to designate such a point as near the point fixed by the levels as a desirable curvature will permit, *and which will produce a curve, from the origin, containing an integer number of chains.* The preceding principles will furnish very simple means of obtaining the desired point; but I cannot *here* enter farther into such details.

12. *Let two curves be under consideration, having different origins, and tangent lines; and let one of those curves be given, from a system of rectangular lines or otherwise, and a point designated therein through which the other curve is required to pass. It is proposed to explain a method by means of which the modulus of curvature of the required curve may be computed.*

Take a system of rectangular co-ordinate axes, corresponding with the given origin and tangent line of each curve respectively, and let the co-ordinates of that point in the given curve which is designated for the required curve to meet, as taken with reference to the co-ordinate axes of the given curve, be $x\,y$; the values of these co-ordinates being computed by article 2, if the given curve be already laid in the field, but determined by means of a system of rectangular lines, when that curve has not been actually laid. Let the co-ordinates of the *new origin,* taken with reference to the axes of $x\,y$, and determined either by computation, or by means of a system of rectangular lines, be denoted by α, β; α *being supposed* to coincide with the axis of x. Take z to denote the given inclination of the tangents at the origins of the two curves.

It is sufficiently obvious that the required modulus of curvature will be immediately derived from article 4, when the co-ordinates of

y', of the designated point, as taken with reference to the new origin and axes, becomes known. The formulas for those new co-ordinates are,

$$x' = \overline{y+\beta}\,.\ \text{Sin.}\,z + \overline{x+\alpha}\,.\ \text{Cos.}\,z$$

$$y' = \overline{y+\beta}\,.\ \text{Cos.}\,z - \overline{x+\alpha}\,.\ \text{Sin.}\,z$$

These are the well known expressions given by most authors for the transformation of rectangular co-ordinates, and they only here stand transposed in such a manner as will best suit the engineer's purpose in the present inquiry. By means of article 4, the above equations immediately produce the following formula, for the value of the new modulus of curvature T':

$$\text{Sin.}\,T' = \frac{\overline{y+\beta}\,.\ \text{Cos.}\,z - \overline{x+\alpha}\,.\ \text{Sin.}\,z}{\overline{y+\beta}|^2 + \overline{x+\alpha}|^2}$$

The theorem thus obtained has a very good form for computation, and when skilfully applied, it will frequently save much labor in the field, which would be otherwise required, *when certain alterations are proposed in a line, once computed, or actually traced.* In the practical use of this theorem, particular attention must be paid to the algebraic *sign* of all the quantities; but this does not *here* require an explanation. VAN DE GRAAFF.

Lexington, Ky., April, 1834.

THE THAMES TUNNEL.—The completion of this great undertaking seems, if practicable, likely soon to be attempted, as several scientific and distinguished persons have lately visited it, and on Monday last Mr. Brunel received many of the members of the Royal Society to view it, and conducted them to its extreme end, where tables were laid out, having drawings, &c., showing the whole progress of the work, the great difficulties that have already been overcome in carrying the tunnel 600 feet under the Thames, and the data upon which the engineer confidently anticipated being enabled to complete this bold undertaking, were the necessary funds supplied. Mr. Brunel, at considerable length, detailed the exertions that have been used to overcome the difficulties arising from the irruption of the river, and stated that in the course of the work the miners had for twenty-seven days pushed on the tunnel over a quicksand. The members of the Royal Society, after leaving the tunnel, proceeded to view the experimental arch constructed on a new plan by Mr. Brunel. The structure is built with bricks and Roman cement, and consists of two semi-arches, springing from the same pier, without any support. By this plan an arch of the greatest span may be constructed without centering, and demonstrating, as the projector observed, the practicability of building a tower of brick-work 50 feet high, and 200 feet in diameter, and sinking the whole gradually in one mass. By this method it is intended to complete the circular and winding carriage approaches to the tunnel. It may be interesting to observe that of the two semi-arches one is shorter than the other, and it has been loaded with about eleven tons of iron for the last nineteen months, without any sensible change in its position. The company, after expressing their high satisfaction at the novelty of the works of the tunnel, and the last invention, partook of a cold collation.—[English paper.]

MECHANICS IN CANTON.—There is no machinery, properly so called, in Canton. Much of the manufacturing business, required for the supply of commercial houses in the city, is done at a town situated at a short distance; still the amount of labor performed in Canton is very considerable. There are about 17,000 persons in Canton employed in silk weaving. The number of persons engaged in manufacturing different kinds of cloth is about 50,000. They occupy 2,500 shops, averaging usually twenty hands in each shop. Some of the Chinese females, who devote their time to embroidery, secure a profit of from twenty to twenty-five dollars per month. The number of shoemakers is more than 4,000. Those who work in wood, brass, iron, stone, and other materials, are numerous; and those who engage in each of these occupations form a distinct community, and are governed by their own laws and regulations in their business. The *barbers* form a separate department. No man can act as tonsor without a license. The number of this fraternity in Canton is more than 7,000. The whole number of mechanics in the city is estimated at 250,000.

CLEANING FURNITURE.—The many accidents arising from the dangerous practice of boiling turpentine and wax for cleaning furniture induces me to send you, from my common-place book, a receipt for the mixture of these articles, which will prove a much superior and more effectual plan than that usually adopted, and by which so many individuals have lost their lives. Put the quantity of turpentine required into a vessel, then scrape the bees' wax into it with a knife, which stir about till the liquid assumes the consistency of cream. When prepared in this manner it will be good for months, if kept clean; and it will be found that the furniture cleaned with the liquor manufactured in this way will not stain with the hand so readily as when the boiling process is adopted. But if some people must have heat in the mixture, it can easily be got, by placing the vessel containing the turpentine and wax into another containing boiling water, which will do the business as well as any fire whatever.—[Architectural Magazine.]

THE *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. MINOR and J. E. CHALLIS, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum in *advance*.—JOHN KNIGHT, (formerly proprietor of the London Mechanics' Magazine,) Editor.

MECHANICS' MAGAZINE,

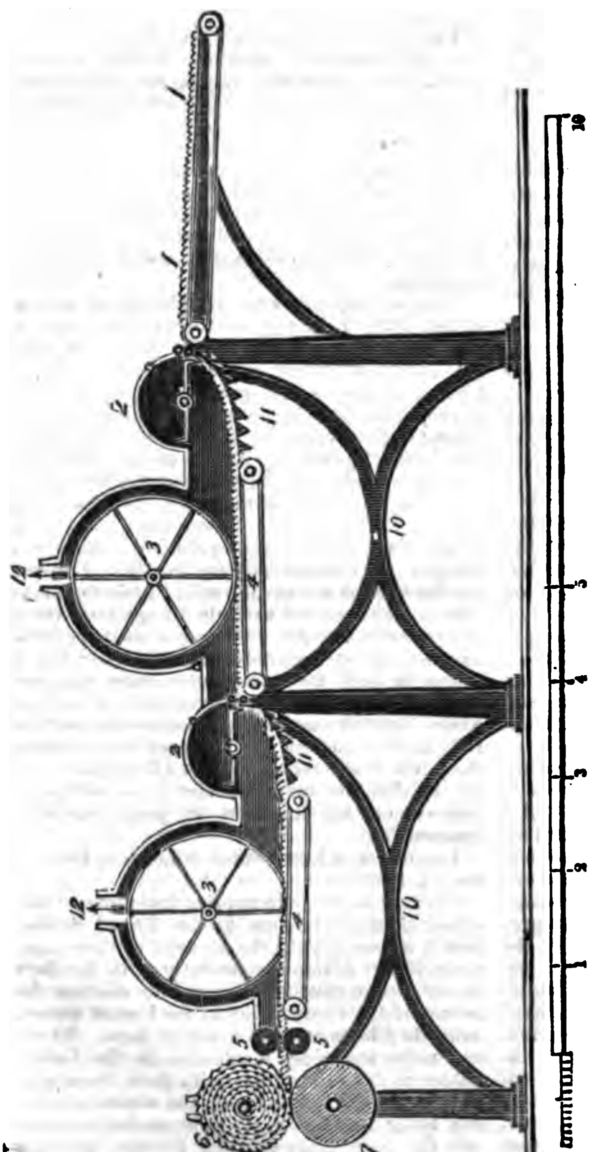
AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FOR THE WEEK ENDING MAY 24, 1834. [NUMBER 5.

"He who does his best, however little, is always to be distinguished from him who does nothing."—DR. JOHNSON.

View of a Cotton Scutching and Lapping Engine, on the most improved plan, the first one invented, by N. SNODGRASS, *of Glasgow, in* 1806. [Communicated by the Inventor for the Mechanics' Magazine and Register of Inventions and Improvements.]



EXPLANATION.

1, 1, Feeding table, with cotton weighed and spread upon it.
2, 2, Scutcher cylinders, 11 inches diameter, to run 1500 revolutions per minute, with covers of iron.
3, 3, Wire gauze cylinders, with covers, to spread the cotton, and let off the air generated by the scutcher cylinders.
4, 4, Feeding cloths and moving wooden rollers, to carry the cotton under the wire cylinders from scutcher to scutcher.
5, 5, Two cast iron rollers, 4 inches diameter, to compress the cotton before it is lapped up on roller No. 6, for the cards.
6, Cotton roller, for the carding engine.
7, An iron or wooden cylinder, about 15 inches diameter, under cotton roller, for winding up the same.
10, 10, A view of one side of the cast iron framing.
11, 11, Triangle ribbed hecks, for extracting the gins, &c. from the cotton, and allowed in Europe to be an important part of the scutching engine.
12, 12, Air apertures, for letting the generated air escape through the gauze wire covered cylinders.

~~~~~~~~ This represents the cotton in process.

New-York, May 14, 1834.

TO THE EDITOR:

Sir,—A few weeks ago I took the liberty of sending you a plan (not mine) for blasting iron ore furnaces with hot air,* successfully in use in Scotland, whereby thirty-three per cent. of fuel is said to be saved; also, a plan of mine for heating factories on the best principles, by steam: in hopes these might benefit this rising country. From the same motive, I again send you another plan of a scutching (batting) machine, for opening, cleaning, and, in one operation, preparing it to be applied to the carding engines; the first one invented by me, in Messrs. G. Houston & Co.'s large

* Which will be inserted shortly.—[ED. M. M.]
~~~~~~~~

spinning factories in the town of Johnstone, Scotland, in 1806, and successfully introduced to the spinning trade in Britain, and, *I believe*, never before in any publication.

The section plan annexed is drawn on a necessarily small scale, to suit the limits of magazines, and is only calculated to suit the understanding of the first rate cotton machine makers, such as Mr. Rodgers, &c. at Paterson. The plan shows all the essential working parts: the various complicated movements, &c. will be easily arranged by these gentlemen, and almost impossible to be exhibited in yours, or any other similar publication. All that I have to observe, in addition to the explanation accompanying the drawing, for the practical working of the machine, in cotton factories, is, that this machine should be made the same breadth of the carding engines, so that the finished lap, No. 6, would suit on applying it. Also, the first feeding cloth, Nos. 1, 1, should be divided into such parts as the manager of the work may think proper, then causing the person that attends the machine to weigh a certain weight of cotton, and carefully spread that weight on each of these parts, which has the effect of enabling the small scutching cylinders to open the cotton more regularly; and, finally, finish the lap, for carding, in the most perfect manner, doing as much work, and better, with one person, than if more were employed, which is the case with those cotton factories I have been permitted to examine in this country. Also, from twenty-eight years' experience, I decidedly recommend, in no case, to make the scutcher cylinders more than *twelve* inches in diameter, and only with two blades. In the mean time, I am, Sir, yours, &c.,

Neil Snodgrass, 87 Pearl st.

Information to Inventors who wish to obtain Patents in England. [From the Journal of the Franklin Institute.]

Inquiries are frequently made of the Editor, by persons who wish to secure patents in England and France for their inventions, and it has been his design to give some general information upon that subject in the Journal. The present article, however, is not considered as fulfilling his intention, but merely as bringing to notice one point of considerable importance in the business. The patent law of the United States provides for the granting of patents to inventors, only, or to their heirs, administrators, or assignees; and a patent obtained by any other person is invalid. In England, patents are granted for what is *new there*, without regard to who was the inventor of it; if invented in a foreign country, the term new applying to its novelty in the realm. Whoever, therefore, first takes a new invention to that country can obtain a patent, and defend his right. It consequently becomes a point of great importance, that those inventions which are deemed worth the expense of an English patent should not be divulged here before steps have been taken to secure the right on the other side of the Atlantic.

The Editor has, in several instances, prepared and transmitted the requisite papers to England, his situation being such as to offer special facilities for so doing. Owing to this, and to his general pursuits, he has become the depository of more information respecting the modes of procedure than has fallen to the lot of most other persons; his connection with the Patent Office of the United States also brought to his notice many things calculated to throw light upon this subject.

There are many persons who make it their special business to visit the United States' Patent Office, that they may be able to turn the inventions of others to their own advantage, either at home or abroad: at home, by making some unimportant change in the form of machines that they see there, and then diffusing them in some part of the Union remote from the residence of the original inventor; abroad, by sending to England and France accounts of such inventions as they believe will sell in those countries.

This subject has been brought afresh to the notice of the Editor by a letter received from a correspondent in New-York, Wm. Serrell, Esq., Civil Engineer, a gentleman from England, and who was frequently employed there in preparing specifications and drawings for the Patent Office, and who has, in several instances, been engaged by American inventors in the same business. In a letter dated March 3d, in which he mentions this fact, he observes, that, "The short period since my first agency of this kind, and the little publicity I have yet sought, are reasons why the number of these transactions is yet small; still, I have the pleasure to say that late arrivals bring advice from my friend in London, that two of such patents are in progress towards profitable sale; but I regret to add, the same letter states that one patent is likely to be interfered with, if not set aside, through some circumstances that will be fully understood by the annexed extract from the letter itself, which extract I hand you, believing that you may consider it of sufficient importance for insertion in your excellent Journal."

Extract of a letter dated "London, December 14, 1833":

"It may be of use to apprize inventors of mechanical improvements in the United States, that it is essential to the security of their interests, if they design to take out patents for their inventions in this country, not to disclose the secret of their inventions in the United States, until they have secured a patent here. There are many ingenious mechanics in the United States in correspondence with their friends in this country, constantly on the watch to seize any thing new, and likely to be useful, to transmit the particulars to their friends, and thus

forestal the rights and interests of the original inventor."

As a commentary upon the foregoing extract, the following fact may be stated. An American had obtained a patent in the United States, and had assigned the right thereto, in England, to a fellow-citizen for twenty thousand dollars; the assignee, however, arrived there too late, as some one had obtained the description from the office here, transmitted it, and obtained a patent.

There is now before the British Parliament a new law to regulate the granting of patents. It passed the House of Commons at the last session, and was read a second time in the House of Lords, but the Lord Chancellor wishing to examine its details with more care than was then possible, it was postponed. It will undoubtedly be completed at an early period, when we shall give its provisions, with such other matter respecting foreign patents as may appear to us important.

Further notice respecting the obtaining of Patents in England.—The Editor has just received a further communication from W. Serrell, Esq., Engineer, New-York, the gentleman referred to in the first article in the present number, in which he has furnished another extract from a letter on the subject of English patents, dated London, 17th February, 1834. As it not only confirms, but gives additional importance to the observations made in the above named article, we hasten to publish it.

"By the way, a man has recently arrived from New-York, named S———, loaded with patents, none of which are his own; amongst them he has got J. R——'s, with the specification and drawings. R—— knows him, and S—— was much surprised to find R—— here, and still more that his patent was secured.

"This is another practical evidence of the importance of the caution which I lately sent to you, and which I hope you have had published. The moment a patent worth any thing is taken out at Washington, one of these kidnappers secures the child as his own, and goes away with it to a foreign market. A patent was recently named to an English tradesman, who directly asked if it was not an American invention; on being answered in the affirmative, he rejoined 'you are too late, my brother saw it in N. York, and when he came home had one made.' The plain result of all this is, that when any thing is invented in America which is deemed worthy of being patented in England, it ought to be secured, but not published in America, until time has been given to secure it in England. You may be assured that there are regular traders, or rather regular plunderers of patents, persons who make this a business, and do nothing else. I could furnish some proofs of the fact."

Mr. Serrell adds, "the first part of the above refers to a patent for an improvement, the inventor of which went hence by my advice, and applied to my friend in London, by whom he has been placed in a situation to obtain a handsome remuneration, all of which would have been jeopardized had S—— left New-York a few weeks earlier. Any unprincipled man, with a small amount of mechanical knowledge, can, by swearing to 'a communication from a foreigner residing abroad,' obtain a patent, unless he is met on the threshold by an opposition which will compel him to show the nature of the communication under which he attempts to procure it.

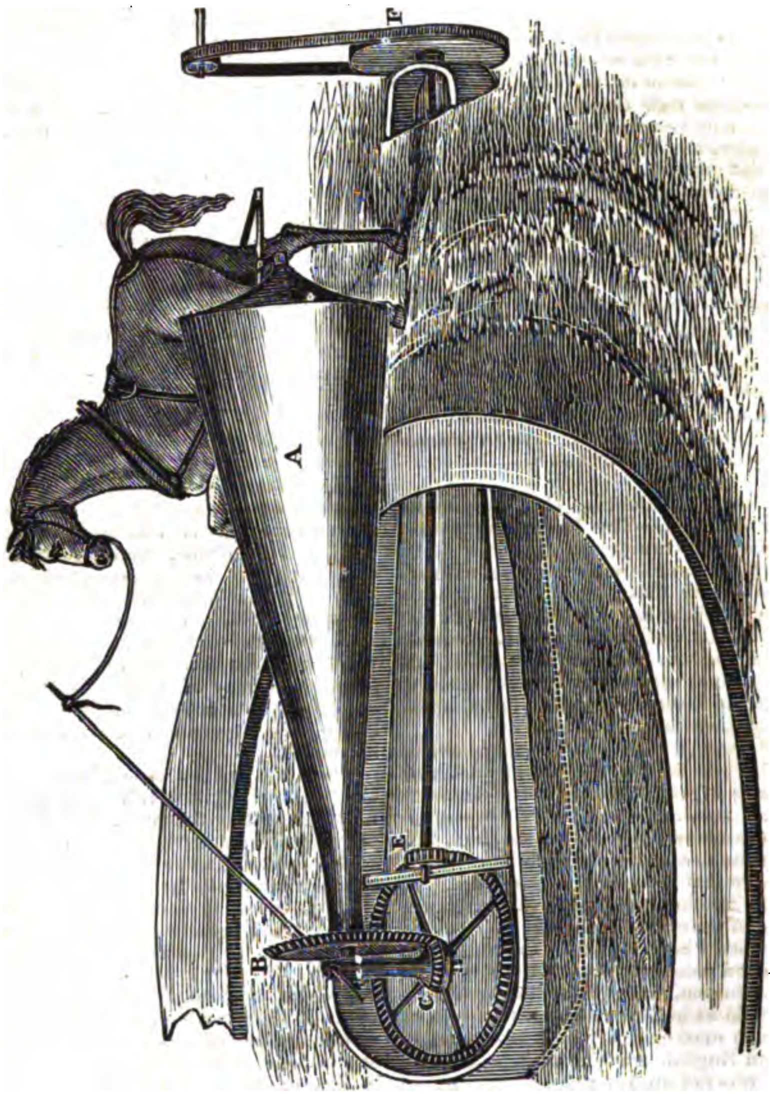
"I forward the preceding extracts and remarks for publication in your Journal, should you think proper so to dispose of them."

The writer of the letter from England probably is not aware of the difference between the practice here and there in the issuing of patents. In England the patent issues upon the title of the invention being furnished, and several months are allowed, most commonly six, for the enrolling of the specification, so that no individual can learn the nature of the invention at the patent office for this length of time after it has been *secured*. In the United States the specification must be furnished before the patent can issue, and the very day that a patentee receives it, any one may obtain a copy of it. The office has no power whatever to refuse such a copy, and no blame, therefore, attaches there, this being the fair construction of the law. The only safe procedure, therefore, when an inventor wishes to secure a patent in England, is to send over, prior to, or simultaneously with, his application here, furnishing to a proper agent, a copy of his specification and drawings, and the necessary funds, otherwise he is likely to be superseded, in which case he has no remedy.

There are but few cases, however, in which an inventor ought to rely upon his own judgment respecting the propriety of obtaining a patent in England; he should obtain the best advice here, and after this be careful that the business goes into the hands of an agent there who has the ability and integrity to direct him aright. An English patent costs about six hundred dollars, for that kingdom alone, and if extended to Scotland and Ireland, about three times that amount. Were all inventions as good as their authors think them, this sum would be one of little comparative moment; but, in point of fact, there is not more than one in fifty of the patents obtained here which would be worth patenting in England, at so great a cost, although what is really new and useful will, in general, be better paid for there than with us.

Industry.—Those who have been trained to habits of industry enjoy life more than those that are indolent. The former are always seeking something to do; the latter are restless, work not being pleasant, and rest not being truly relished. The life of an inactive lazy man is unseasoned, very insipid, and unpalatable.

Economy.—He who saves in one way, that he may enjoy his savings in a more rational one, is the true philosopher: he will do good while living, and be remembered with respect when dead.



Description and Drawing of Beecher's Portable Horse Power. Communicated by the Inventor.

This power is applicable to all purposes where speed is necessary, particularly to thrashing, grinding, turning, and sawing. Its superiority consists in the simplicity of the gear: only two wheels of 23 and 30 inches, with pinions of 9 and 6 inches, are necessary to get a speed of two to three hundred revolutions per minute. The power being obtained by a revolving lever on a smooth surface, it is not liable to break by sudden impetus, or stoppage. It requires no frame or building, but is simply fastened to the ground or floor. The lever may be increased in length without diminishing the speed. It may be removed and erected in three hours' time. It can be placed in a back yard or cellar, and it makes no jarring in the building.

References.—A, revolving lever; B, driving wheel; C, nine-inch pinions; E, line shaft; and F, band wheel.

This horse power may be seen in the yard of the Railroad House, 98 Barclay street, New-York. The right to territory may be obtained of the inventor at the above place. Machines of one, two, three, or four horse power furnished to order at 60, 75, 90, and 100 dollars.

A portable cider mill and press to be seen as above.

History of Astronomy—its various Systems, &c. [Continued from page 231.]

OF THE FIXED STARS.—The fixed stars are considered by astronomers as forming no part of the solar system, but as placed far beyond the utmost limits of it. They have supposed that each star is a sun, having a number of planets and comets circulating round it, and that each of the planets thus circulating round those luminaries may be a habitable world like our own.

The strongest argument for this hypothesis is, that fixed stars cannot be magnified by the most powerful telescopes, on account of their extreme distance. Hence it is concluded, that they shine by their *own* light; and that each of them is a sun, equal, if not superior, in lustre and magnitude to our own.

When the stars are examined through a telescope, they rather seem diminished than increased in size. This circumstance alone would have been a striking proof of the immeasurable distance of these bodies, had we not been in possession of still more convincing evidence. In every attempt which astronomers have made with the best of instruments to discover the *parallax* of the stars, they never found it to amount to *one* second, even when the earth was in opposite points of her orbit; and therefore they have determined that the nearest of these luminaries cannot be less than 206,265 times the radius of the earth's orbit. As light traverses the latter in 8′ 13″, it will require 3 years and 79 days to come from a fixed star to the earth. And it is believed some of them may be so remote that their light has not yet reached the earth since they were created; while others, which have disappeared, or have been destroyed many ages ago, may continue to shine in the heavens till the last ray which they emitted has reached our globe.

The number of stars discoverable at any time in the heavens, by the naked eye, is not above a thousand. This may at first appear incredible to some, because they seem to be innumerable; but the deception arises from looking upon them hastily, without reducing them into any kind of order. For let any person look steadily a little time upon a large portion of the heavens, and count the number of the stars in it, and he will be surprised to find the number so small. And if the moon be observed for a short space of time, she will be found to meet with very few in her way, although there are as many about her path as in any other part of the heavens.

Flamstead's catalogue of the stars in both hemispheres contains only 3000; and a great number of these cannot be seen without the assistance of a telescope. When the heavens are examined with a good telescope, the stars are not found to be uniformly scattered over the firmament. In some places they are crowded together; and in other parts there are large spaces where no stars can be seen. Besides these starry groups, where the individual stars are distinctly visible, there are numbers of small luminous spots, of a cloudy appearance, called *Nebulæ*. The largest of these nebulæ is the galaxy, or milky way, a white luminous zone which nearly encircles the heavens, and which appears to be the nearest of all the nebulæ.

While the heavens exhibit these appearances, which may be termed *constant*, they occasionally exhibit others of a different kind, which seem to arise from some great physical changes that are going on in the universe. Several new stars have appeared for a time, and then vanished; some that are inserted in the ancient catalogues can no longer be found, while others are constantly and distinctly visible, which have not been described by any of the ancients. Some have gradually increased in lustre; others have been gradually diminishing; and a great number sustain a *periodical* variation in their brilliancy.

In order to explain these singular changes, astronomers have supposed that the stars are suns, having part of their surface occupied by large black spots, which, in the course of their rotation about an axis, present themselves to us, and thus diminish the brilliancy of the star. Some astronomers suppose the black spots to be permanent; but others are of opinion that the luminous surface of these bodies is subject to perpetual change, which sometimes increases their light, and at others extinguishes it.

The stars are divided into orders or classes, according to their apparent magnitudes. Those that appear largest to the naked eye have been called stars of the first magnitude; those that appear next largest, the second magnitude; and so on to the sixth, which comprehends the smallest stars that are visible to the naked eye. All those that can only be perceived by the help of a telescope are called telescopic stars.

The stars of each class are not all of the *same* apparent magnitude. In the first class, or those of the first magnitude, there are scarcely two that appear of the same size.

There are also other stars of intermediate magnitudes, which astronomers cannot refer to any particular class, and therefore they place them between two; but on this

subject astronomers differ considerably: some of them classing a star among those of the first magnitude, while others class it among those of the second, and so on with others.

In fact, it may be said that there are almost as many orders of stars as there are stars, on account of the great varieties observable in their magnitude, color, brightness, &c. Whether these variations of appearance are owing to a diversity in their real magnitudes, or from their different distances, it is impossible to determine; but it is highly probable that both of these causes contribute to produce these effects.

To the naked eye the stars appear of a sensible magnitude, owing to the glare of light arising from the numberless reflections from the aerial particles, &c. about the eye. This makes us imagine the stars to be much larger than they would appear if we saw them only by the few rays which come directly from them, so as to enter our eyes without being intermixed with others. Any person may be sensible of this by looking at a star of the first magnitude through a long narrow tube, which, though it takes in as much of the heavens as would hold a thousand such stars, it scarcely renders that one visible. The stars being so immensely distant from the earth, there seems to be but little probability of ascertaining with certainty the real magnitude of any of them.

And, as the late Sir W. Herschel has very justly remarked, "that in the classification of stars into magnitudes, there is either no natural standard, or at least none that can be satisfactory; and that the astronomers who have thus classed them have referred their size or lustre to some imaginary standard."

The same illustrious astronomer observes, "That the inconvenience arising from this unknown, or at least ill-ascertained standard, to which we are to refer, is such that all our most careful observations labor under the greatest disadvantage. If any dependence could be placed on the method of magnitudes, it would follow that many of the stars had undergone a change in their lustre, or apparent magnitude, even since the time of Dr. Flamstead. Not less that eleven stars in the constellation Leo have undergone a change of lustre since his time." This change Sir W. Herschel believes has arisen from the uncertainty of the standard of magnitudes, and not from any real change in the lustre of stars; and in order to prevent mistakes of this nature to future observers, Sir William proposes to compare the lustre of any particular star with one that is greater, and also with one that is less, both of which are to be as near the proposed star as possible. This he thinks would answer much better for detecting a change in the lustre of any suspected star, than the vague method of magnitudes, which has been hitherto in use among astronomers.

As a full display of Sir W.'s method would occupy more space than can be allotted to it in this work, those who wish to have more information on the subject may consult the Philosophical Transactions, Vol. 86.

The variation in the light of the stars has been ascribed to the interposition of the *planets* that revolve round them; but it is not probable that the planets are sufficiently large to produce any sensible effect, of this kind, at least.

Of Eclipses.—Of all the various phenomena of the heavens, there are none which have created so much curiosity, excited so much interest, or caused so great terror, throughout the world, as eclipses of the sun and moon; and to those who are unacquainted with the principles of astronomy, there is nothing, perhaps, which appears more extraordinary than the accuracy with which they can be predicted.

In the earlier ages of the world, before science had enlightened the minds of men, appearances of this kind were generally regarded as alarming deviations from the established laws of nature; and but few, even among philosophers themselves, were able to account for these extraordinary appearances. At length, when men began to apply themselves to observations, and when the motions of the celestial bodies were better understood, these phenomena were not only found to depend upon a regular cause, but to admit of a natural and easy solution. There are, however, nations that still entertain the most superstitious notions respecting eclipses, particularly the Mexicans and Chinese.

Thus when the infant moon her circling sphere
Wheels o'er the sun's broad disk, her shadow falls
On earth's fair bosom; darkness chills the fields,
And dreary night invests the face of heaven.
Reflected from the lake, full many a star
Glimmers with feeble languor. India's sons,
Affrighted, in wild tumult rend the air.
Before his idol god, with barb'rous shriek,
The Brachman* falls: when soon the eye of day
Darts his all-cheering radiance, from the gloom
Emerging. Joy invades the wond'ring crowd,
And acclamation rushes from the tongues
Of thousands, that around their blazing pile
Riot in antic dance and dissonant song.—[Zouch.]

Many instances are to be found, not only in ancient, but even in comparatively modern

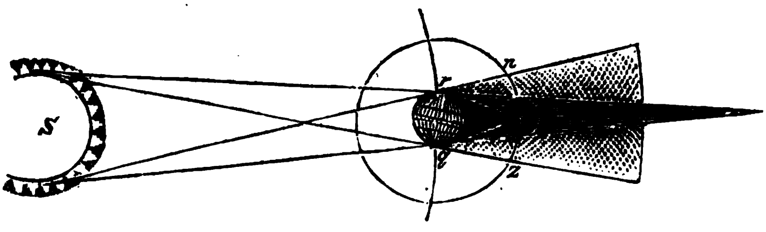
---

* Although the Chinese perform the most ridiculous and superstitious ceremonies during the time of an eclipse, yet they can calculate them with the greatest precision.

history, where the superstition of the times has continued to connect the records of eclipses with the details of some remarkable event, which either happens soon after or during their continuance. But these details being foreign to the nature of the present work, we shall proceed to give an account of the causes, and various kinds of eclipses of the sun and moon.

As every planet belonging to the solar system, both primary and secondary, derives its light from the sun, it must cast a shadow towards that part of the heavens which is opposite to the sun. This shadow is, of course, nothing but a privation of light in the space hid from the sun by the opaque body, and will always be proportionate to the relative magnitudes of the sun and planet. If the sun and planet were both of the same size, the form of the shadow cast by the planet would be that of a cylinder, the diameter of which would be the same as that of the sun or planet, and it would never converge to a point. If the planet were larger than the sun, the shadow would continue to spread or diverge; but as the sun is much larger than the greatest of the planets, the shadows cast by any one of these bodies must converge to a point, the distance of which from the planet will be proportionate to the size and distance of the planet from the sun. The magnitude of the sun is such that the shadow cast by each of the primary planets always converges to a point before it reaches any other planet, so that not one of the primary planets can eclipse another. The shadow of any planet which is accompanied by satellites may on certain occasions eclipse these satellites; but it is not long enough to eclipse any other body. The shadow of a satellite or moon may also, on certain occasions, fall on the primary and eclipse it.

Eclipses of the sun and moon happen when the moon is near her nodes, that is, when she is either in the plane of the ecliptic or very near it. Those of the sun happen only at new moon, or when the moon is in conjunction with the sun; whilst those of the moon happen at the time of *full moon*, or when the moon is in opposition to the sun. The sun, earth, and moon, must, therefore, always be nearly in the same straight line at the time of an eclipse; and conversely, when these three bodies are nearly in a straight line, an eclipse must take place. Hence it is evident, that an eclipse happens in consequence of one of the two opaque bodies, the earth and the moon, being so placed as to prevent the sun's light from falling on the other. See the following figure, which represents the moon passing through the dark shadow of the earth, as she moves in her orbit, *n z*, while the earth moves in the ecliptic, *r q*.



The interposition of the moon between the sun and the earth produces an eclipse of the sun; and the interposition of the earth between the moon and the sun, so that its shadow falls on the moon, produces an eclipse of the moon. On these principles the whole phenomena of eclipses depend, and admit of complete explanation.

If the moon's orbit were coincident with the plane of the ecliptic, the moon's shadow would fall upon the earth, and occasion a *central eclipse* of the sun at every conjunction, or new moon; whilst the earth's shadow would fall on the moon, and occasion a total eclipse of that body at every opposition, or full moon. For as the moon would then always move in the ecliptic, the centres of the sun, earth, and moon, would all be in the same straight line at both of these times. But the moon's orbit is inclined to the ecliptic, and forms with it an angle of about 5° 10′; and therefore the moon is never in the ecliptic, except when she is in one of her *nodes*: hence there may be a considerable number of conjunctions and oppositions of the sun and moon without any eclipse taking place.

The moon is always at some distance from the ecliptic, except when she is in one of her *nodes*; and this distance is called her *latitude*, which is north or south, according as the moon is on the north or south side of the ecliptic. Now, if the moon has any latitude, there cannot be a *central* eclipse, for this can only happen when the moon is in one of her nodes at the moment of con-

junction, which is very seldom the case; and, of course, very few central eclipses of the sun have taken place since the creation of the world.* But the section of the earth's shadow (through which the moon passes when she is eclipsed) being much larger than the disc of the moon, the moon may be *totally* eclipsed, although she be at some distance from her node at the time of opposition; but its duration will be the greater the nearer she is to the node. An eclipse of the *sun* may also happen, although the moon be at some distance from her node at the time of conjunction; but its form, as well as its duration, depend very much upon that distance. This circumstance has occasioned the division of eclipses into central, total, annular, and partial.

As the meaning of these terms must be obvious to the reader, it is almost unnecessary to give an explanation of them.

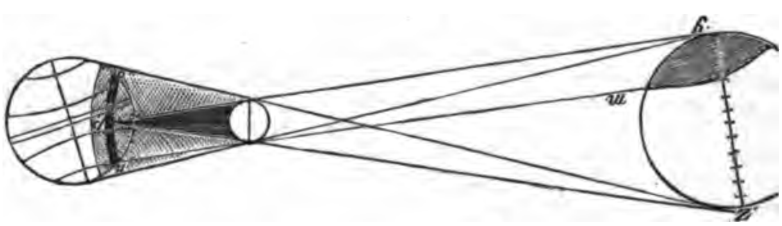
A central eclipse is that in which the centre of the shadow falls on the centre of the body which is eclipsed.

A total eclipse is the obscuration of the whole body eclipsed.

An annular eclipse is that in which the whole of the body eclipsed is hid, except a ring round its edge, which remains luminous.

A partial eclipse is that in which part of the eclipsed body is hid from view.

The following figure represents a partial eclipse of the sun, which will be visible to that tract of the earth marked *n p o*, the line *m n* marks the greatest obscuration.



If the distance be very small, the eclipse will be the greater and continue the longer; but no eclipse of the sun can be either *central* or total, except the moon be in the very node at the time of conjunction. But should she be in this situation, when she is at her least distance from the earth, and the earth at the same time at its least distance from the sun, then the eclipse will not only be central, but *total*, and continue so for a few minutes. But if the moon happens to be at her greatest distance from the earth, and the earth at its greatest distance from the sun, the eclipse will be annular, or a small space round the sun's centre only will be hid from view, and a bright lucid ring round his edge will remain visible.

If the moon be less than 17½ degrees from either node at the time of conjunction, her shadow will fall more or less upon the earth, according as she is more or less within this limit; and, of course, the sun will suffer a partial eclipse. And if she be less than 12½ degrees from either node at the time of opposition, she will pass through more or less of the earth's shadow, according as she is more or less within these lines, and of course she will suffer an eclipse.

As these limits form but a small part of the moon's orbit, which is 360 degrees, eclipses happen but seldom; however, in no year can there be fewer than two, and there may be seven of the sun and moon together; but taking one year with another, there are about four each year. But as the sun and moon spend as much time below the horizon of any place as above it, half the number of the eclipses will be *invisible* at any particular place, and consequently there will be only *two* eclipses visible in a year at that place: the one of the sun and the other of the moon.*

Every eclipse, whether of the sun or moon, is visible at some place of the earth's surface, and invisible at others; for the rational horizon of every place divides both the earth and heavens into two equal portions or hemispheres; and as no celestial body can be seen except it be above the spectator's horizon, it follows that any eclipse which is visible in one hemisphere cannot be visible in the other, because the body which is eclipsed is below the horizon of that other. If a lunar eclipse, for example, happens at any hour of the night, between the time of sun-setting and sun-rising, at any particular place, it will be visible there and invisible to the inhabitants of the opposite hemisphere, who have the sun

* One of the most remarkable eclipses of this kind which has ever happened was visible in Britain and several other countries, on the 7th of September, 1820.

* If there be seven eclipses in any year, five of them must be of the sun and two of the moon.

above their horizon at that time; for the sun and moon are in opposite parts of the heavens at the time of a lunar eclipse. And with respect to solar eclipses, it is evident that they can only be seen at any place when the sun is above the horizon of that place. There is, however, a difference with regard to the visibility of a solar and lunar eclipse; for an eclipse of the moon has the same appearance to all the inhabitants of that hemisphere to which the moon is visible at the time, owing in part to the small distance of the moon from the earth. But an eclipse of the sun may be visible to some places and invisible to others in the same hemisphere of the earth, because the moon's shadow is small in comparison of the earth; for its breadth, excluding the penumbra, is only about 180 miles, even in central eclipses.* Hence, those places which are considerably distant from the path of the shadow will either have no eclipse at all, or a very small one; while places near the middle of the shadow will have the greatest possible. There is also a difference in the absolute time at which a solar eclipse happens at the various places where it is visible; for it appears more early to the western parts, and later to the eastern, on account of the motion of the moon (and of course her shadow) from west to east.

In most solar eclipses the moon's disc may be observed by a telescope to be covered by a faint light, which is attributed to the reflection of light from the illuminated part of the earth. When the eclipses are total, the moon's limb is surrounded by a pale circle of light, which some astronomers consider as an indication of a lunar atmosphere, but others, as occasioned by the atmosphere of the sun, because it has been observed to move equally with the sun, and not with the moon.

Dr. Halley, in describing a central eclipse of the sun, which happened at London in April, 1715, says, that although the disc of the sun was wholly covered by the moon, a luminous ring of a faint pearly light surrounded the body of the moon the whole time, and its breadth was nearly a tenth of the moon's diameter.

In lunar eclipses, the moon seldom disappears entirely; and on some occasions even the spots may be distinguished through the shade; but this can only be the case when the moon is at her greatest distance from the earth at the time of the eclipse, for the nearer the moon is to the earth the darkness is the greater. In some instances the moon has disappeared entirely; and the celebrated astronomer, Heraclius, has taken notice of one where the moon could not be seen even with a telescope, though the night was remarkably clear.

Although eclipses of the sun and moon were long considered by the ignorant and superstitious as presages of *evil*, yet they are of the greatest use in astronomy, and may be employed to improve some of the most important and useful of the sciences. By eclipses of the moon the *earth* is proved to be of a *globular* form, the sun to be *greater* than the *earth*, and the *earth* greater than the *moon*. When they are similar in all their circumstances, and happen at considerable intervals of time, they also serve to ascertain the real period of the moon's motion. In geography, eclipses are of considerable use in determining the longitude of places, and particularly eclipses of the moon, because they are oftener visible than those of the sun, and the same eclipse is of equal magnitude and duration at all places where it is seen. In chronology, both solar and lunar eclipses serve to determine exactly the time of any past event.

For the purpose of finding the longitude at places on the earth, eclipses of Jupiter's satellites are found much more useful than eclipses of the moon; not only on account of their happening more frequently, but on account of their instantaneous commencement and termination.

When Jupiter and any of his satellites are in a line with the sun, and Jupiter between the satellite and the sun, it disappears, being then eclipsed, or involved in his shadow. When the satellite goes behind the body of Jupiter, with respect to a spectator on the earth, it is said to be *occulted*, being hid from our sight by his body, whether in his shadow or not. And when the satellite comes into a position between Jupiter and the sun, it casts a shadow on the face of that planet, which is seen by a spectator on the earth as an obscure round spot. Lastly, when the satellite is in a line with Jupiter and the earth, it appears on his disc as a round black spot, which is termed a transit of the satellite.

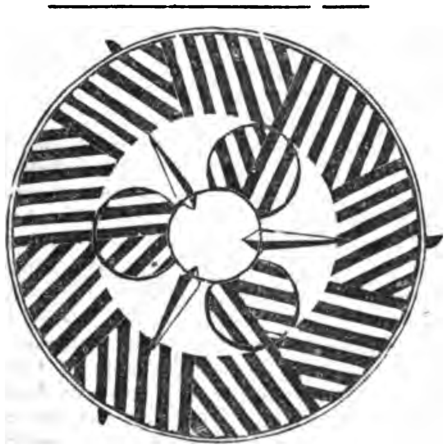
As those phenomena appear at the same moment of *absolute* time at all places on the earth to which Jupiter is then visible, but at different hours of *relative* time,* according to the distance between the meridian of the places at which observations are made, it

* A penumbra is the faint shadow produced by an opaque body when opposed to a luminous one.

* *Absolute* time is that which is computed from the same moment; *relative* is that which is computed from different moments.

follows that this difference of time converted into degrees will be the difference of longitude between those places. Suppose, for example, that a person at London observed an eclipse to begin at 11 o'clock in the evening, and that a person at Barbadoes observed the same at 7 o'clock in the evening, it is certain the eclipse was seen by both persons at the same moment of absolute time, although there is four hours difference in their manner of reckoning that time; and this converted into degrees (at the rate of 15 degrees to an hour) is the difference of longitude between these two places; therefore, Barbadoes is 60 degrees *west* from London, the time not being so far advanced there as at London.

Another phenomenon, somewhat similar to an eclipse, sometimes takes place, by which the longitude of places may be determined, although not quite so easily, nor perhaps so accurately, as by the eclipses of Jupiter's satellites. This is the hiding or obscuring of a fixed star or planet by the moon or other planet, which takes place when the moon or planet is in conjunction with the star. Appearances of this kind are termed occultations. They are very little attended to except by practical astronomers, who employ them for the correction of the lunar tables, and settling the longitude of places, as already stated.



Great Improvement in Mill Stones.—The accompanying drawing represents an improvement in mill stones, which, from the following certificates, would seem to be of very great importance. It consists principally in letting in the air, as is denoted in the drawing, on the flour while grinding, and in expediting the operation. The patentee, James Preslow, and the original purchaser, George B. Jeffery, reside at Auburn.

Auburn, March 18, 1833.

We, the subscribers, having examined the plan for which James Preslow has obtained a patent for the discovery of an improvement of preparing mill stones to expedite the grinding of grain, and also seen an experiment of the grinding of grain at the mills of Carhart and Polhemus, in the village of Auburn, with mill stones prepared and dressed according to the improvement for which said patent is obtained, do hereby certify that we were present at said mills, and saw fifteen and a half bushels of wheat ground with one run of stones in a superior manner, for flour, within the space of one hour.

Ambrose Cock,
I. S. Miller.
E. Miller.

Manlius, May 18, 1833.

We, the subscribers, having had our plaster mill stones dressed by Mr. James Preslow, according to his method of dressing, and from the experiment do believe it to be the greatest improvement that has ever been offered to the public, feel bound to say in this certificate, that by the experiment tried, our mill ground twice the quantity in the same given time, and equally fine. And we believe that in dressing plaster mill stones according to said Preslow's method, that the quantity can be quite or nearly doubled: we therefore cordially recommend it to the patronage of the public.

Jacob R. De Prey.
James I. D'Elery.

Milford, June 4, 1833.

Fifty-two busnels and a half in four hours and forty-nine minutes, the flour very good. We have no hesitation in recommending the improvement, from our own experiment as well as from the science and respectability of the gentlemen engaged in the improvement.

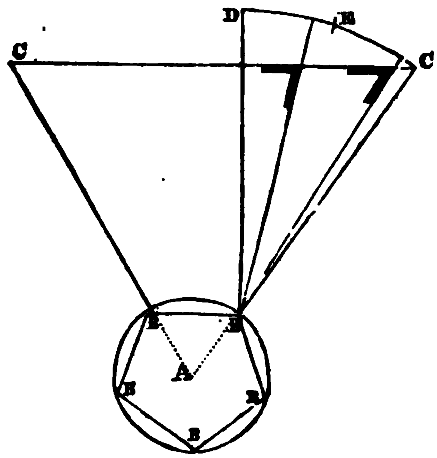
Disborough & Ludlow.

Application may be made to Mrs. White, corner of Beekman and Pearl streets, New-York.

On the Construction of Hatters' Planks. By Erastus Stanley. To the Editor of the Mechanics' Magazine.

Sir,—Some twelve years since, Mr. Joseph Bull, of this village, was in want of two sets of hatters' planks made, and having been at great expense heretofore in getting them made, it being a difficult piece of work for those that are not acquainted with making them, it frequently being the case that the stock is so much wasted as to make it very expensive, he suggested that there might be a rule devised whereby the stock might be cut to better advantage than heretofore. I, therefore, being a mechanic, commenced studying on the subject, and after some days I devised the following rule, from which I

have made several sets in less than one-third of the time usually occupied in making them, besides a saving of one-fourth of the stock.



Draw a circle two inches in diameter larger than the outside of the kettle, A. Divide it into five parts, as B B B B B. Draw lines from the centre through B as far out as the width of the plank, as B C; then draw a line from B perpendicularly to D; then set one foot of the compasses at B, and extend the other to C, and draw the curve C D. Divide C D into forty-five parts: divide C D into two equal parts, E for eight and a half inches rise; set off two and one-eighth parts from C towards E, and draw a line to B, which line, and the line C C, gives the bevel for the end of the plank B C; then set off four and one-fourth parts from E, towards D, and draw a line to B, which line and the line C C gives the bevel for the edge of the plank.

N. B.—The under side is the work side, and the upper edge is the work edge of the plank.

I have not made this invention known, in hopes of being benefitted by it, but it being my fortune not to make any thing by speculation, I have concluded to communicate it (if you think it worthy a place) to the public through your Magazine. Yours, &c.,

ERASTUS STANLEY.

Canandaigua, April 30, 1834.

Specification of a Patent for an Improvement in Wheels for Cars and Locomotive Engines, to be used upon Railroads. Granted to ROSS WINANS, *Civil Engineer, city of Baltimore, November* 19, 1833.

To all whom it may concern, be it known that I, Ross Winans, of the city of Baltimore, in the state of Maryland, Civil Engineer, have invented an improved mode of constructing wheels for cars and locomotive engines, to be used upon railroads, and that the following is a full and exact description thereof.

The more clearly to exhibit the difference between my improved wheel and those which have been heretofore employed, I will briefly point out the manner in which wheels for this purpose have been most commonly made; not intending, however, as it is not necessary for the purpose in view, to notice all the plans which have been adopted.

1st. Such wheels have been made wholly, or nearly so, of cast iron; the face, or tread of them, being cast within a *chill*, consisting of a thick rim, or hoop, of iron, which forms a part of the mould.

2d. The wheels have been cast without being chilled, and aftorwards hooped with wrought iron, which then forms the face and flanch of the wheel.

3d. A cast iron nave, or hub, has been made to receive wooden spokes, inserted in wooden felloes, which were hooped with a tire of wrought iron.

4th. The hubs have been of cast iron, with spokes of wrought iron, and a rim of wrought or of cast iron, hooped with wrought iron.

These plans have each their respective advantages and disadvantages, but neither of them has fully answered the purpose for which it has been adopted; the wrought iron hoop, or tire, upon the cast iron rims have gradually become loosened; the wooden spokes and felloes have pressed the one into the other, and the tire has ceased to bind them, an evil which wedging will not cure. To remedy these defects, and others incident to some of the wheels, is the object of my improvement.

My wheel consists essentially of three parts, namely, an *interior wheel*, the hub, spokes, and rim of which are of cast iron; a *rim of wood*, formed in a way to be presently described, surrounding the cast iron wheel; a *hoop or tire of wrought iron*, surrounding the wood, and forming the face, or tread, of the wheel.

The inner wheel is made, in some respects, like those first noticed, but the face is not chilled, nor has it the same form with the chilled face. It should be made of the same width on the rim, with the wrought iron tire which is to surround and form the tread or the wheel, say five inches. The face of the cast rim may be cylindrical for the greater part of its width, but it must in this case have a fillet, or edge, projecting up on each side of it, say to the height, and of the thickness, of half an inch, which will then give to it the

appearance of a wheel with a double flanch, having a cylindrical tread of four inches in width. Instead of making the face in this form, I intend sometimes to give to it a regular declination from each edge towards the centre. A section of the rim, transversely, would then be somewhat in the form of the letter V, but with the angle obtuse. The inclination will be sufficient if the diameter at the centre of the rim is one inch less than that at the sides, or edges. Other forms may be given to the face of the rim, by which the object in view may be attained, namely, that of retaining the wooden rim in its place, without its allowing it to move out on either side.

A rim of wood is to be placed around this wheel, which may consist of any convenient number of pieces, fitted to each other, and to the face of the wheel. The grain of the wood is to cross the rim of the wheel, running parallel with its axis. These pieces may be fitted to the face of the wheel with greater facility by driving them into a large hoop, running as a chuck in a lathe, by which means they may be turned to the form required; they may then be fastened on to the rim by wood screws, or otherwise, and turned thereon to receive the iron hoop or tire. The best thickness of this rim will be from two to four inches.

The *hoop, or tire, of wrought iron*, is to be made in the usual form, turned truly, and passed on over the wooden rim when expanded by heating it as highly as may be done without burning the wood. Bolts are then to be passed through the wrought iron, the wood, and the cast iron rims, which are secured by nuts, to confine the whole together.

The hub, or nave, in a wheel thus made, may be cast entire, instead of having those divisions, or openings, which are necessary in the chilled wheel, to allow for contraction. Although I have described the spokes and rim as being of cast iron, either or both of them may be of wrought iron, but it would be more costly, without affording any adequate advantages; those of cast iron being perfectly safe in this mode of construction.

It will be readily perceived that the wood, thus pressed between two hoops of iron, has an extent of bearing surface which will effectually prevent its being condensed by the force to which it is subjected; whilst, by its elasticity, it will tend to preserve both the road and the vehicles passing over it. If perfectly dried when put on, which may be done by artificial heat, the wood will never shrink, but, on the contrary, will expand, and render all the parts the more firm. Such a wheel will have less tendency than any other, where wood is employed, to get out of truth; and should wedging become necessary, it may be done more effectually than with any other.

The dimensions of most of the parts of such a wheel need not differ greatly from those of the cast iron wheels with chilled rims, but, like them, must vary according to their diameter, and the load they are to sustain; the following is a good proportion for wheels of three feet in diameter, intended for cars carrying three tons.

Cast iron interior wheel, twenty-nine inches diameter; hub, seven inches long by six in diameter; spokes, twelve in number, five-eighths of an inch thick, and three and a half or four inches broad; rim, five inches broad by five-eighths of an inch thick; wooden rim, two and five-eighths inches thick, five inches deep, measuring across the rim; wrought iron tire, seven-eighths of an inch thick, five inches broad; flanch, one and one-fourth inch deep, one inch thick.

Although I have described the rim of wood as placed with its grain crossing the rim of the wheel, and am fully convinced that this is the best manner of placing it, yet it will answer the purpose, to a considerable extent, when running in the direction of the rim, and I do not intend, therefore, to limit myself in this respect, as what I claim as my invention is the interposing a rim or belt of wood between an interior wheel of cast or of wrought iron, and a wrought iron rim or tire, and securing the whole together in the manner and for the purposes hereinbefore set forth.

Ross Winans.

Newly Invented Railways. Communicated by the Inventor. To the Editor, &c.

Dear Sir,—I have now finished planting trees, for the present season at least, and snatch the first moment's time to fulfil the promise I have made you respecting my newly invented railways. I now give you a description, though an imperfect one, of this notable contrivance.

The supports of the railways are constructed out of common dock logs, which, in the first instance, are to be subjected to the operation of being well charred. Their butt ends are then to be inserted in the ground three or four feet deep, and surrounded by ruple stones well rammed in. The height of these supports will depend upon circumstances, from one hundred feet high down to not less than ten.

In order to give to these supports a due degree of stiffness and strength, I propose making the ways double, which will afford sufficient room to give them these properties. The spaces longitudinally between these supports, according to circumstances, may be occasionally extended to 500 feet, perhaps to a thousand. Whenever the extension is considerable, a suf-

ficient number of lighter supports may be used. These may probably be made to give the necessary support without being inserted in the ground.

I shall now proceed to describe the mode of constructing the rails. In the first place, round iron, from a quarter to a half an inch in thickness, must be stretched across from pillar to pillar. These iron rods must be placed immediately under the rails—three to each rail. On these the rails are formed of common plank, extending the whole length, placed one on the top of the other, breaking joints. The whole number of the plank thus layed will depend on circumstances, perhaps 8 or 10 may prove sufficient. A proper cement must be used between each layer of the plank, to connect the whole into one solid mass. When the rails are thus formed, a shoeing of some species of hard wood must be laid on, for the wheels to run on. These wheels must be tired with hard wood instead of iron. It is contemplated that, thus elevated above the dust and mud of common roads, they will last a long time.

The expense of a rail constructed as above would be small indeed when compared with the railroads now in use. It probably would not cost one-fourth of the latter, where iron is universally in use. But, independently of the difference of expense in the construction, as well as in the reparation of such a road, the advantages to be derived from its use are numerous and important. Its elevation not only protects it from dust, &c., but places it out of the reach of all interruptions, and permits also the passage across its path below of all sorts of other carriages in all directions. The farmer, instead of his usual dread of a railroad across his premises, will, on the contrary, court the approach of such a railroad as above described, as a great convenience in his various transportations, without incommoding him in any way. Whilst the railroad is passing over his head, he pursues his different agricultural avocations on the surface of the ground uninterruptedly. The room the supports occupy is too trivial to be noticed; but another most important circumstance is, that it completely does away with all necessity of embankments and deep cuttings, leaving the ordinary surface of the ground free and clear; and, should the undulating project prove really advantageous, it would enjoy all the benefits arising from that source, exempted from all extra expense.

But there is one source of improvement which had nearly escaped my memory. The forward wheels, perhaps all the wheels, should have attached to each of them a wheel of a foot or 18 inches diameter, revolving horizontally, so placed that its periphery shall approach the inner side of the rails within half an inch, when the carriage is passing through the middle of the road, so as to prevent much deviation therefrom whenever the wheels come in contact with either side of the rails. The mode now in use of preventing the carriage wheels from running off the ways is clumsy, and attended with much friction, so as to occasion considerable wear and tear. In order to prevent the carriage wheels from slipping on the ways, the periphery thereof should be covered with Indian rubber or leather made perfectly water tight.

Your obedient servant, J. S.

Hoboken, May 10, 1834.

Railroad from Tuskaloosa to Tuscumbia. To the Editor of the American Railroad Journal and Advocate of Internal Improvements.

North Port, Ala., April 25, 1834.

Sir,—Sometime in the fall of 1832, No. 36 of the Railroad Journal came into my hands. I am not absolutely certain that it is still published in New-York, though I am informed that it is. My object in writing at this time is to request you to send me a Number of the Journal, if it is still published. On the receipt of it I will transmit to you the subscription price of one copy for one year, and perhaps more. The reason for my wishing to subscribe for the Railroad Journal is, that through the medium of it, to give publicity to the designs and wishes of so many of the people of this State who are anxious for a railroad between Tuskaloosa and Tuscumbia, a distance of about 100 miles, or a little over. It is not my intention to dilate on this subject at this time. It is sufficient, for the present, to mention, briefly, that in the event of the existence of this road, 100,000 bales of cotton, now raised in *Tennessee valley*, could get to market in going one-third the distance they are now carried. The goods taken in exchange would return on the same road. There would then be a direct communication, by means of the Tennessee river, which runs nearly north from Tuscumbia into the Ohio, from Cincinnati and the immense country of the West, to Mobile, consequently, all the rope, bagging, twine, flour, bacon, potatoes, whiskey, and a variety of other articles, that now go the long route to New-Orleans, Mobile, and thence up our rivers, would come down the railroad to Tuskaloosa, and through the middle of Alabama to Mobile. The goods taken in exchange would return back on the road. Flour, bacon, and potatoes, on account of the delay in going to New-Orleans, and the hot weather, are frequently spoiled before arriving here. The great north and south travel is another important consideration; and also that the country through which this road would pass abounds in *stone coal*. Tuskaloosa is at the head of navigation, on the Black Warrior river. North Port is opposite the town of Tuskaloosa, on the other side of the river, and ships between 3 and 4000 bales of cotton annually.

Very respectfully, C. S.

A railroad from the Tuscumbia and Decatur Railroad to Tuskaloosa will add greatly to the facilities and conveniences of business men in the interior of Alabama. We consider the projectors of the Tuscumbia, Courtland, and Decatur Railroad among the true benefactors of the State. *That road*, short as it is, *will become the centre of action.* It will, within a few years, be continued to the Atlantic on

the east, the Mississippi on the west, the gulf of Mexico on the south, and the Ohio on the north; and will be intersected by numerous other shorter railroads from all the principal towns in their vicinity.

RAILROAD FROM MEMPHIS TO BOLIVAR.—Extract of a letter, dated "Memphis, Tenn., April 22, 1834," addressed to the Editor of the Railroad Journal, &c.

"SIR,—I am now engaged in the preliminary survey of a railroad from Memphis, through Summerville, to Bolivar. It is intended to connect this with Jackson, and thence to Columbia, and thence probably to Nashville. Probably, in a few years, Nashville will be connected to Louisville on the Ohio River. Casting your eye on a map of Tennessee and Kentucky, you will see the extent of such a railroad. We strongly anticipate a connection with Charleston via Tuscumbia. Numbers in this place wish to take your Journal. I hope to send you something more substantial than words when next I write.

"Very respectfully, JOHN THOMPSON."

The writer of the above has our best wishes for his success, as well in his survey as in obtaining subscribers to the Journal.

FORCE OF TRACTION.—Experiments uniformly show that the force of traction is, in every case, nearly in an exact proportion to the strength and hardness of a road. The following are the results: On a well made pavement, the power required to draw a waggon is 33 lbs.; on a road made with six inches of broken stone of great hardness, laid on a foundation of large stones, set in the form of a pavement, is 46 lbs.; on a road made with a thick coating of broken stone, laid on earth, the power required is 65 lbs.; and on a road made with a thick coating of gravel, laid on earth, the power required is 147 lbs. Thus it appears that the results of actual experiments fully correspond with those deduced from the laws of science."—[Parnell's Treatise on Roads.]

A PREVENTION FOR DRY ROT.—It has been discovered by experiment, that dry rot in oak can be prevented by a simple process, and at a moderate expense. It consists in steeping the timber in a vat prepared for the purpose, with bark, in a mode similar to that used in tanning. The time required to accomplish this object varies from two to three months, when the timber becomes saturated with the bark, and its durability and antiseptic powers are rendered such as to be capable of resisting decomposition for an indefinite period. The wood ought previously to be formed into the shape in which it is intended to be used. This system is not only much safer as regards health, and more economical and convenient in its application than that in which corrosive sublimate is used, but a comparative trial will prove the remedy proposed more effective in its operation and certain in its results.

STATISTICS OF FRENCH MANUFACTURES.—The principal manufactures of France may be dated from the reign of Louis XIV., whose minister, the celebrated Colbert, invited foreign artists and artisans of every kind and of distinguished merit into the kingdom, and encouraged them by premiums to fix their establishments in France. But towards the end of his reign, that monarch, by his revocation of the Edicts of Nantes, and his persecution of the Protestants, in a great measure destroyed the advantages arising from the foreign establishments, by forcing thousands of artisans to seek refuge in England, and the Low Countries, into which they introduced those branches of industry, especially silk. Thus France lost the services of some of her most ingenious mechanics through the folly of an infatuated monarch.

To give an idea of the manufactories of France, it is sufficient to cite the draperies of Louviers, Sedan, Elbeuf, Castres; the cambrics of Valenciennes and Cambray; the pier-glasses of St. Gobain, whose dimensions are occasionally ten feet in height by four and five feet broad; the cotton manufactories of St. Quentin, Rouen, &c. &c.; the linens of Brittany, Dauphiny, and the northern provinces; the laces of Lille, Alencon, Valenciennes, and Puy; the silks of Lyons, Avignon, Nimes, and Tours; the tapestries of the Gobelins, at Paris; the carpets of La Savonnerie and Aubusson, which, in beauty of design and brilliancy of colors, rival those of the east; the porcelain of Sevres, her manufactories of clocks and watches, jewellery, crystal, mock diamonds, bronzes, fire arms, &c. To these might be added an immense number of manufactories which were wholly unknown in France half a century ago, such as files, needles, wool-cards, &c.

We have learned from official sources, that the capital employed in manufactures amounts to 1,820,105,409 fr., which is applied as follows:

In indigenous materials,	416,000,000 fr.
In materials imported,	186,000,000
In wages, . . .	844,000,000
In general expenses, as wear and tear of machinery and tools, repairs, fuel, lights, interest of money, invested as fixed capital, which being deducted from the gross amount leaves 182,105,409 francs for the profit of the manufacturers, .	192,000,000

The annual produce of the principal

branches of industry in 1828 has been calculated in round numbers as follows:

Thrown silks, silk stuffs, gauzes and crapes,	160,000,000 fr.
Cloths and woollen stuffs,	250,000,000
Linen drapery and thread lace	210,000,000
Stationary,	25,000,000
Cotton,	200,000,000
Lace,	10,000,000
Hardware,	125,000,000
Coal, and other produce of mines and quarries,	30,000,000
Watches and clocks,	30,000,000
Gold and silver articles,	50,000,000
Jewellery,	40,000,000
Glass, plate glass, china, pottery, bricks,	80,000,000
Lime and plaster,	15,000,000
Salts and acids,	30,000,000
Soap,	30,000,000
Refined sugar,	15,000,000
Hats,	30,000,000
Leather,	160,000,000
Dye and varnish,	50,000,000
Perfumery,	15,000,000
Books,	30,000,000
Beer,	60,000,000
Cider and perry,	50,000,000
Brandy,	75,000,000
Upholstery and musical instruments,	50,000,000
Total,	1,820,000,000 fr.

Having enumerated the principal manufactures in France, we shall state from official information the progress made in the productions of those manufactories from 1812 to 1827. In the first place, we find that under the government of the empire, when Belgium and the left bank of the Rhine were under her dominion, France in 1812 employed in her manufactories 35 millions kilogrammes, or 70 million pounds of native wool. In 1816 the quantity of native wool, with the amount imported of foreign wool, for fine cloths, merinos, and cachemires, &c. was in the whole 80 million French pounds, which, with the difference of nearly ten per cent., is equal to 90 million lbs. English. In 1824 and 1826 the quantity of wool used in the manufactories amounted to 48 millions of kilogrammes, making an increase in the consumption of wool in 14 years of 26 millions of French pounds, or more than one million English tons.

In 1812, the quantity of cotton spun into thread did not exceed 10,362,000 kilogrammes. The consumption in 1816 amounted to 12 millions of kilogrammes; in 1825, the quantity manufactured was 26 millions; in 1826, 32 million kilogrammes of cotton employed in prints, calicoes, tulles, &c.: thus the consumption has been more than tripled in 14 years. The consumption of silk has not less increased in proportion to wool and cotton. In 1816, France imported 400,000 kilogrammes of silk; in 1824 and 1825, 650,000 kilogrammes; and in 1826, not less than 800,000 kilogrammes, notwithstanding the progress made and encouragement given to breeding of silk worms in the country. In 1816, the quantity of coals extracted from the mines did not exceed 1000 million kilogrammes; in 1826, they furnished 1500 million kilogrammes. In 1814 and 1816, the quantity of iron manufactured amounted to 100 millions, and in 1825 and 1826, it had increased to 160 millions of kilogrammes.—[Goldsmith's Statistics of France, and Rep. Pat. Inv.]

Sponge.—This well known marine production has been in use from very early times, and naturalists were long embarrassed whether to assign it a place in the animal or vegetable kingdom. Most authorities now agree in putting the sponges in the lowest scale of animal life. There are about fifty different species of sponges, of which nine or ten belong to this country. They are found in the Mediterranean and those seas in warm and temperate latitudes, diminishing in number and becoming of inferior quality on the approach to cold regions. They adhere to rocks in places the least exposed to the action of currents and waves, which the ebbing tide does not leave uncovered. The best sponges known to us are those which come from the Archipelago, where they abound near many of the islands, whose inhabitants may be said to subsist by the sponge-fishery, if we may so call it. At the Cyclades, for instance, sponge-diving forms the chief employment of the population. The sea is at all times extremely clear, and the experienced divers are capable of distinguishing from the surface the points to which the sponge is attached below, when an unpractised eye could but dimly discern the bottom. Each boat is furnished with a large stone attached to a rope, and this the diver seizes in his hand on plunging head foremost from the stern. He does this in order to increase the velocity of his descent; thus economizing his stock of breath, as well as to facilitate his ascent when exhausted at the bottom, being then quickly hauled up by his companions. Few men can remain longer than about two minutes below; and, as the process of detaching the sponge is very tedious, three, and sometimes four divers de-

scend successively to secure a particularly fine specimen.

The best sponge is that which is the palest and lightest, has small holes, and is soft to the touch. By the old physicians, sponge was regarded as a cure for a long list of maladies; this last is now much abridged, though burned sponge, in which form only it is used, still has a place in the materia medica.—[Penny Magazine.]

Indian Rubber Water-Proof.—This substance is every day becoming of increasing importance. For harness and various other farming and domestic purposes, it will at no distant day be used. The following is from the Ohio State Journal:

Having heard much said of late in favor of Jewitt's water-proof, as rendering leather perfectly tight, I witnessed an experiment on Saturday last, showing the improvement of the leather as to its durability; and were there not a number of the most respectable citizens present, I should hesitate to state the fact and publish it to the world. Two pieces of leather, of equal thickness, were tried upon a grindstone, under a pressure of a weight of 12 lbs. In the first place, the leather in its natural state was placed upon the stone, which was revolved 1500 times; then the piece saturated underwent the same operation 3000 times; and when compared, it was found not to be so much worn as the leather in its original state. From the test made, I have no hesitation in giving it as my opinion, that leather thus prepared will last twice as long as that in its original state. When it is considered that in addition to its rendering leather perfectly impervious to water, it adds 100 per cent. to the wear, its value to the American people is almost incalculable.

P. H. Olmsted.

Columbus, March 18, 1834.

From the Eclectic Journal we extract the following:

In our former notices of this valuable article, we omitted mentioning particularly its beneficial applicability to all kinds of leather harness. It could not fail to have been observed by every individual who has had the opportunity, that those parts of harness composed of leather are, in general, injured infinitely more by wetting and drying, both by rain and sweating of the horse, than by friction or actual wear. By wetting and drying, the leather becomes hard and unpliant, in which condition it cracks and breaks. But let the harness be saturated with the water-proof, and neither water nor sweat can penetrate it, and the leather must remain as soft and pliable after exposure to wet as before. This will certainly render the harness more durable, as well as less liable to chafe or gall the horse.

In conclusion, we will repeat the suggestions of Col. Jewitt, that his composition will be equally as applicable to wood as leather, and by excluding the water from its pores, vastly increase its durability. If future experiment confirms this suggestion, as we have strong reason to hope it will, the advantages which hydraulics, and particularly the shipping interest, will receive from this discovery, will be incalculable.

Chinese Mode of Computing.—The Chinese method of computing is by a kind of abacus, which they call a *Swanpan*, "counting-board." It consists of a frame of wood, of various sizes, divided into two unequal compartments, by a bar placed crosswise, at about one-third the length from the top. Through this bar, at right angles, are inserted a number of parallel wires, and on each wire, on the lower compartment, are five moveable balls; and in the upper two. These wires may be considered as the ascending and descending powers of a numeration table, proceeding in decimal proportions; so that if a ball on any of the wires in the larger compartment be placed against the middle bar, and called unity or one, a ball on the next wire above it will represent ten, and one on the next one hundred; so also a ball on the next lower, one hundredth; and the balls on the corresponding wires in the smaller compartment will, in the same manner, represent five, fifty, five hundred,—five tenths, five hundredths, &c. the value or power of each of those in the smaller division being always five times as much as those in the larger. In China almost every trade has a distinct system of secret numbers, that is, instead of using the proper characters for designating prices, they adopt other characters, by which they arbitrarily express their meaning, so as to be understood only by persons of the same trade.—[Martin's History of the British Colonies, Vol. I., Asia.]

The Chinese Wall.—According to a statement in the "Morgenblatt," the celebrated Chinese wall was erected 213 years before the birth of Christ, against the Mongolese. It is 714 German miles long, 14 feet thick, and 28 feet high; so that with the same materials, a wall, one foot in thickness and 28 in height, might be carried twice round the whole world.

A fossil ship containing sculls and bones, both human and brute, has recently been discovered at New Romney, on the coast of England. The earth has been removed so as to display her whole form, a clinker built craft, and tunnel fastened, having only one mast, being 54 feet long by 24 wide. Curiosity has been much excited by its development.

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*.—John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

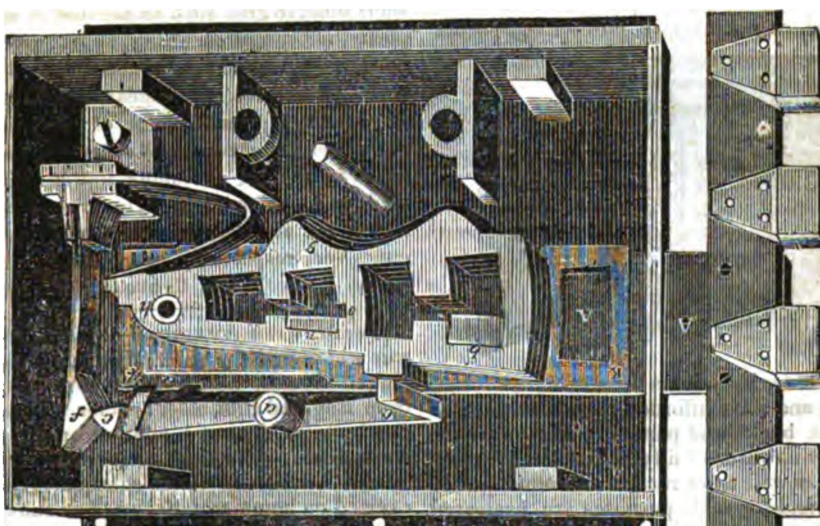
MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS

VOLUME III.] FOR THE WEEK ENDING MAY 31, 1834. [NUMBER 5.

"Without mechanics a general cannot go to war, or fortify a place; and the meanest artificer must work mechanically, or not work at all; so that all persons whatever are indebted to this art, from the king down to the cobbler."—EMERSON.



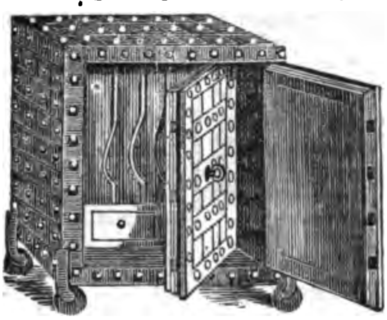
CHUBB'S PATENT LOCK.—The lock made by C. J. Gayler, of 102 Water street, New-York, of which a drawing is annexed, affords more security than any other yet invented, as *it cannot be picked* or opened with any false instrument; and its combinations are so extensive that tens of thousands may be made without making two alike.

Description—A A *a*, the bolt; *b*, the square pin of the bolt; *c c*, the detector, moving on the centre *d*; *f*, the detector spring; *g*, four tumblers, moving separately on the centre *h*, shown lifted by the key to the exact position for the square pin *b* of the bolt to pass, in unlocking. Should one or more of the tumblers be lifted by a pick or false key, in the least degree beyond their present position, the detector, *c c*, being thus overlifted, will, by the angle of the spring, *f*, pressing on the opposite side of the angle of the detector, force its hook into the notch *a* of the bolt, and be firmly held so, until disengaged by the regulating slide K *k*; in which case, by the introduction of the key, the tumblers are lifted to the regulating combination, and admit the stud *n*, affixed to the regulating slide, to enter the several grooves, *o*, in them; the bevelled end *k* of this slide, by the same movement, pressing against the hook of the detector, disengages it from the notch *a* of the bolt.

It possesses the four principal requisites of a good lock, namely, security, simplicity, strength, and durability; its security, particularly, is increased beyond calculation, by an improvement (the detector) which not only renders it impossible to be picked, but also *detects the first attempt to do so*, thereby preventing those repeated efforts to which all other locks are exposed: at the same time it will be noticed that the thief, in making the attempt, renders the lock more secure, for if the detector is (as it must be in such cases) overlifted, it will force its hook into the bolt, and will there remain until it is disengaged, *which can only be done with the true key*, in the following manner: the key must be turned half way round in the lock in the same way as in locking; then turn back again, and then turn round in the

usual way to unlock. If an attempt has been made to pick the lock, the detector will be overlifted, and catch in the bolt; this circumstance will at once be known, when the true key will not open the lock until the detector is disengaged in the way above mentioned. As to its durability, it is not liable to be injured by constant use; this has been fully ascertained by a lock having been locked and unlocked by steam power *four hundred and sixty thousand times* without receiving the least injury.

Mr. Gayler makes use of this lock in all his Double Fire Proof Chests, of which the annexed engraving is a correct representa-



tion. They have been several times tested by fire, and have afforded perfect security to valuable books and papers. They are now in use in upwards of fifty banks in the United States, as well as in record and other public offices, and for such purposes are preferred to vaults, as they are equally safe against fire, are free from damp, and can be removed from one building to another with little trouble or expense.

On Hussey's Reaping Machine. By Cyrus H. M'Cormick. To the Editor of the Mechanics' Magazine, and Register of Inventions and Improvements.

Rockbridge, Va., May 20, 1834.

Dear Sir,—Having seen in the April number of your "Mechanics' Magazine," a cut and description of a reaping machine, said to have been invented by Mr. Obed Hussey, of Ohio, last summer, I would ask the favor of you to inform Mr. Hussey, and the public, through your columns, that that principle, viz., cutting grain by means of a toothed instrument, receiving a rotatory motion from a crank, with the iron teeth projecting before the edge of the cutter for the purpose of preventing the grain from partaking of its motion, is a part of the principle of my machine, and was invented by me, and operated on wheat and oats in July, 1831. This can be attested to the entire satisfaction of the public and Mr. Hussey, as it was witnessed by many persons: consequently, I would warn all persons against the use of the aforesaid principle, as I regard and treat the use of it, in any way, as an infringement of my right.

Since the first experiment was made of the performance of my machine, I have, for the mutual interests of the public and myself, been laboring to bring it to as much perfection as the principle admitted of, before offering it to the public. I now expect to be able, in a very short time, to give such an account of its simplicity, utility and durability, as will give general, if not universal satisfaction. The revolving reel, as I conceive, constitutes a very important, in fact, indispensable part of my machine, which has the effect, in all cases, whether the grain be tangled or leaning, unless below an angle of 45° to the ground, to bring it back to the cutter, and deliver it on the apron when cut. Very respectfully, yours, &c.

Cyrus H. M'Cormick.

Trade with America.—Previous to the war which ended in the independence of the United States, that country was supplied from England with most articles which were required for domestic comfort or household decoration. Although the industry and skill of the Americans have subsequently been exerted on home manufactures as substitutes for these foreign commodities, yet such has been the growing prosperity of both countries since that period, that the average annual amount of the exports from England to the United States of America is now much more than quadruple what it was between the years 1750 and 1760.

The official value of the medium annual exports to the whole of the Americas, both North and South, between the years 1749 and 1755, was £2,001,690; between the years 1784 and 1792, £5,605,626; in 1830, £21,117,014. For the United States alone, the exports from this country, in 1830, were £8,236,677; and if to this amount be added £2,619,562, the value of the exports in the same year, to the British possessions in North America, the value will be £10,856,239. This amount is nearly equal to the £10,915,778, which was the total amount of exports from England in 1760, to all parts of the world except India and China: the value of the exports to the latter places only amounted to £736,358.

The almost entire dependence of the British North American colonies upon the parent country for a supply of almost every

article of commerce and luxury, is curiously illustrated by an order sent to Glasgow for supplies for General Washington's family, in the general's own hand-writing, and dated the 20th of September, 1759.* We think this document will be found of interest, not only as illustrating the character of some part of our trade with America at the early period to which we have alluded, and as showing the relative position of the two countries with regard to arts and manufactures previous to their dismemberment, but as exhibiting a great public character interesting himself in family arrangements, and in the minute details of private life. It will be remembered, that with the same hand which on this occasion penned an order for a ribbon to adorn his wife, and barley sugar for his children, he had a few years after to sign the treaty of peace, whereby the independence of his country was fully recognised.

"2 beaver hats, plain, each to cost a guinea; 1 sword-belt, of red morocco leather, or buff—N. B., no buckles or rings; 4 lbs. of ivory blacking; 2 best two-bladed knives; 1½ reams of paper; 2 flowered lawn aprons; 2 pair of woman's white silk hose; 6 pair of fine cotton ditto; 4 pair thread ditto; 1 pair black and 1 pair white satin shoes of the smallest sizes; 6 pair woman's best kid gloves; 6 pair ditto mittens; 1 black mask; 1 dozen most fashionable pocket handkerchiefs; 2 pair neat small scissors; 1 lb. sewing silk, shaded; 4 pieces binding tape; 10 M. pins (different sizes); 3 lbs. Scotch snuff; 3 lbs. best violet Strasburgh; 1 piece white satin ribbon, pearl edge; 1 case of pickles; 1 large Cheshire cheese; 4 pounds green tea; 10 gross best corks; 1 hhd. best porter; 10 loaves of double and 10 of single refined sugar; 3 snaffle bridles; 9 best girths; 25 pounds brown soap; 2 dozen packs playing cards; 2 sacks best English oats; 1 dozen painter's brushes; 12 best hand padlocks; 16 bell-glasses for garden; more chair bottoms, such as were wrote for in a former invoice; 1 more window curtain and cornice; busts of copper enamel, or glazed, viz., of Julius Cæsar, of Alexander the Great, of Charles XII. of Sweden, and another of the King of Prussia—these all to be of the same size, in order to fill up broken pediments over doors, and not to exceed 15 inches in height nor 10 inches in width; Prince Eugene and the Duke of Marlborough, of somewhat smaller size than the above; sundry small ornaments for a chimney-piece that is 6 feet long and eight inches broad; 100 lbs. white biscuit; two lanterns; various cloths (as specified), with buttons and thread, enough to make up into clothing; 40 yards coarse jean or fustian for summer frocks for negro servants; 1 piece dowlass at 10d.; ½ dozen pair coarse strong thread hose for negro servants; 450 ells Osnaburgs; 350 yards of Kendal cotton; 100 yards Dutch blankets; 20 lbs. brown thread; 20 sacks of salt; a large quantity of different kinds of nails (specified); 2 dozen best staples; sets of cooper's and joiner's tools; 5 lbs. white sugar candy; 10 lbs. brown ditto; 1 lb. barley sugar; a large quantity of drugs and horse medicines of different sorts (specified)."—[Penny Mag.]

* The list has already been published in Dr. Cleland's "Statistical Account of Glasgow," having been taken from Mr. Dugald Bannatyne's "Common-place Book," into which it had been transcribed from the original document. We have been obliged by our limits to abridge it greatly.

Indian Rubber Carpets.—Having some Indian rubber varnish left, which was prepared for another purpose, the thought occurred to me of trying it as a covering to a carpet, after the following manner. A piece of canvass was stretched and covered with a thin coat of glue, (corn meal size will probably answer best,) over this was laid a sheet or two of common brown paper, or newspaper, and another coat of glue added, over which was laid a pattern of house papering, with rich figures. After the body of the carpet was thus prepared, a very thin touch of glue was carried over the face of the paper to prevent the Indian rubber varnish from tarnishing the beautiful colors of the paper. After this was dried, one or two coats, (as may be desired,) of Indian rubber varnish were applied, which, when dried, formed a surface as smooth as polished glass, through which the variegated colors of the paper appeared with undiminished, if not with increased lustre. This carpet is quite durable, and is impenetrable to water or grease of any description. When soiled, it may be washed like a smooth piece of marble or wood. If gold or silver leaf forms the last coat, instead of papering, and the varnish is then applied, nothing can exceed the splendid richness of the carpet, which gives the floor the appearance of being burnished with gold, or silver. A neat carpet on this plan will cost (when made of good papering) about 37½ cents a yard. When covered with gold or silver leaf, the cost will be about $1.00 or $1.50 a yard.

American Mangle.—This instrument, invented and patented by Mr. I. Doolittle, of Bennington, Vt., we have seen used, and we have conversed also with those who have employed it, and find that its use saves a

great portion of the labor, and all the fuel, usually employed in the process of ironing table and bed linen, towels, &c., besides being much more expeditious, and giving the articles a better lustre and whiter appearance. It is regarded as a valuable auxiliary, and by some is reckoned among the indispensable utensils of the laundry.

THE NEW PIN.—There are few things which more strikingly exemplify the high point of civilization to which this country has attained than the amount of capital continually expended, the inventive talent exercised, and the powerful agencies employed, as the remedy of exceedingly small evils, and the attainment of equally minute objects of convenience. This remark cannot perhaps find a better illustration than in "The New Pin with an Immoveable Solid Head." The defect in the old pin, which it is the object of the present improvement to remedy, is that the head of the pin being separately spun and then put on, was liable to be detached by the pressure of the thumb. The principle of the improvement consists in this: that the head being formed of the same piece with the body of the pin, the inconvenience attending its slipping is effectually prevented. This is the minute improvement in a minute article, the accomplishment of which has cost the patentees several years of attentive application, and the expenditure of a large capital, according to their own statement, which, when the extent and character of the machinery employed are considered, there can be no reason to doubt. At the same time, it must be taken in connection with this improvement, that the patent pin is altogether produced by machinery, instead of partly by hand processes. "The Patent Solid-headed Pin Works" are situated about a mile from Stroud, on the Bath and Birmingham road. The principal building consists of five floors, each of them one hundred feet in length, and completely filled with machinery. A large iron water-wheel, on which a stream acts with a power equal to that of forty horses, gives motion to all the mechanical apparatus, which is so ingeniously constructed as to perform every essential operation for converting a coil of wire into the perfect pin with scarcely any noise and little apparent effort. Upon the old system, this comparatively insignificant article had to go through fifteen or sixteen hands before it was finished; but this curious machine effects the whole without manual assistance, or any extraneous aid whatever; for the wire being placed on a reel, and the machine set in motion, all the mechanical combinations, so numerous and dissimilar in their movements, are simultaneously performing their various functions with a rapidity and precision truly surprising. While one portion of the apparatus is drawing out and straightening the wire, and cutting it off at the required length, another combination is pointing and polishing the pin, and another compressing a portion of the wire into dies to form a perfect and neat round solid head. The various movements are completely at command, and susceptible of instant alteration and adjustment to pins of any length, and heads of any form, while the machine is working at its ordinary speed. Each machine operates on four wires at once, and from forty to fifty pins are with facility produced in a minute by each of the 100 machines which are completed, and in constant operation at the works. As a more particular detail of the process would not be well understood without engravings, we shall only further state that the works, with the present number of machines, are capable of producing upwards of two tons of pins weekly, or, stating the amount numerically, 3,240,000 pins daily, 19,440,000 weekly, supposing all the machines to be in operation twelve hours daily. It is stated that altogether twenty millions of pins are daily manufactured in this country for home consumption and for the foreign market.—[Penny Magazine.]

STEREOTYPE METALAGRAPHIC PRINTING.—*By Dr. Alexander Jones, of Mobile, Alabama.*—I offer this name, as I have nothing better to designate it. It means simply the transferring of printed letters, from the pages of a book, or newspaper, to the polished surfaces of metallic plates, especially of soft iron. My experiments are not yet completed, yet I feel satisfied that the result is entirely a practicable one, if carefully conducted with proper instruments.

The best plan on which to conduct the experiment is as follows: Take two plates of very soft iron, of moderate dimensions, give one face of each a very true and fine polish, so that, when applied by these faces, they shall uniformly fit and adhere together. Moisten two slips of printed newspaper, or parts of a leaf from a book, of the size of the plates, apply one to the polished face of each plate, and interpose between them a fold or two of silk paper, and then clamp the plates together. Give them a gentle heat over the fire, then place them in a vice, and apply a strong screw power. On separating them and gently removing the paper, the letters will be seen, distinctly formed on the faces

of the two plates. Now, as printer's ink is formed of *lamp-black and oil*, upon which acid acts very little, the faces of the plates may be slightly touched over with diluted sulphuric or nitric acid, which, if skilfully applied, acts on the iron, and leaves the letters raised. When the printer's ink contains some bees-wax, the experiment is more complete. These plates, once formed, may be converted into steel, on the plan of Mr. Perkins; after which they would probably print from 10,000 to 20,000 copies without being materially defaced. An expert mechanic, with proper machinery, could in a day or two form a sufficient number of plates to print off 20,000 copies (500 pages) of an octavo volume.

Other metals, as copper, brass, and type metal, with slight variations, can all have letters transferred to them in the same manner, and can be used as printing plates; but none of these will have the durability of iron. —[American Journal of Science.]

The Locust.—The locust belongs to that class of insects which naturalists distinguish by the name of *gryllus*. The common grasshopper is of this genus, and in its general appearance resembles the "migratory locust," of which we have to speak. The body of this insect is long in proportion to its size, and is defended on the back by a strong corslet, either of a greenish or light brown hue. The head, which is vertical, is very large, and furnished with two antennæ of about an inch in length: the eyes are very prominent, dark, and rolling: the jaws are strong, and terminate in three incisive teeth, the sharp points of which traverse each other like scissors. The insect is furnished with four wings, of which the exterior pair, which are properly cases to the true wings, are tough, straight, and larger than those which they cover, which are pliant, reticulated, nearly transparent, and fold up in the manner of a fan. The four anterior legs are of middling size, and of great use in climbing and feeding; but the posterior pair are much larger and longer, and of such strength that the locust is enabled by their means to leap more than two hundred times the length of its own body, which is usually from two to three inches. Locusts, as the writer of this article has seen them in the east, are generally of a light brown or stone color, with dusky spots on the corslet and wing-cases; the mouth and inside of the thighs tinctured with blue, and the wings with green, blue, or red. These wings are of a delicate and beautiful texture; and in the fine fibres, by which the transparency is traversed, the Moslems of western Asia fancy that they can decypher an Arabic sentence, which signifies "We are the destroying army of God."

The female locust lays about forty eggs, which in appearance are not unlike oat-grains, but smaller. She covers them with a viscid matter, by which they are sometimes attached to blades of grass, but are more usually deposited in the ground. For this purpose she prefers light sandy earths, and will not leave the eggs in compact, moist, or cultivated grounds, unless she has been brought down on them by rain, wind or fatigue, and rendered incapable of seeking a more eligible situation. Having performed this, the female dies; and the eggs remain in the ground throughout the winter. If much rain occurs, the wet spoils them, by destroying the viscid matter in which they are enveloped, and which is essential to their preservation. Heat also seems necessary to their production, for the little worm which proceeds from the egg sometimes appears so early as February and sometimes not until May, according to the state of the season. This, in the usual course, becomes a nymph, in which state it attains its full growth in about twenty-four days. After having for a few days abstained from food, it then bursts its skin, comes forth a perfect animal, and immediately begins to unfold and trim its wings with the hinder feet. The insects which first attain this state do not immediately fly off, but wait in the neighborhood for those whose developement is more tardy; but when their army is formed, they take their flight from the district.

To those who have not seen a flight of locusts, it is difficult by description to convey an idea of the appearance it presents. As seen approaching in the distance it resembles a vast opaque cloud, and as it advances a clattering noise is heard, which is occasioned by the agitation and concussion of wings in their close phalanxes. When they arrive they fill the air, like flakes of thick falling snow; and we have known the bright and clear sky of Chaldea become darker than that of London on some heavy November day.

Wherever they alight, every vegetable substance disappears with inconceivable rapidity before them. The most beautiful and highly cultivated lands assume the appearance of a desert, and the trees stand stripped of all their leaves as in the midst of winter. After devouring the fruits, the herbage, and the leaves of trees, they attack the buds and the bark, and do not even spare the thatch of the houses. The most poisonous, caustic, or bitter plants, as well as the juicy and

nutritive, are equally consumed; and thus "the land is as the Garden of Eden before them, and behind them a desolate wilderness." It seems as if nothing could appease their devouring hunger, and the energy and activity they exhibit, and the rapidity of their operations, almost exceed belief. Their depredations are not confined to the open air: they scale the walls, and penetrate to the granaries and houses. They swarm from the cellar to the garret; and, within doors and without, they are a terrible nuisance, for they are continually springing about, and often, in consequence, give a person startling raps on different parts of the face, affording very sensible evidence of the force with which they leap; and, as the mouth cannot be opened without the danger of receiving a locust, it is impossible to converse or eat with comfort. When they have settled themselves at night, the ground is covered with them to a vast extent; and, in some situations, they lie one above another several inches thick. In travelling, they are crushed beneath the feet of the horses; and the animals are so terribly annoyed by the bouncing against them in all directions of the insects they have disturbed, that they snort with alarm, and become unwilling to proceed.

It is not merely the living presence of these insects which is terrible, but new calamities are occasioned by their death, when the decomposition of their bodies fills the air with pestilential miasma, occasioning epidemic maladies, the ravages of which are compared to those of the plague. Thus famine and death follow in their train; and instances are not of rare occurrence in the east in which villages and whole districts have been depopulated by them.

Under these circumstances it necessarily becomes an object of anxious attention, in the countries they are most accustomed to visit, either to prevent them from alighting on the cultivated grounds, or to drive them off or destroy them after they have descended.

The impression is very general that noise frightens these insect devastators, and prevents them from alighting. When, therefore, the people are aware of the approach of their armies, every kettle or other noisy instrument in the place is in requisition, with which, and by shouts and screeches, men, women, and children, unite in the endeavor to make the most horrible din in their power. The scene would be truly laughable, from the earnestness which every one exhibits in this strange employment, were not all disposition to mirth checked by the consciousness of the fearful consequences of the invasion which it is thus endeavored to avert.

How far noise may really operate in preventing their descent in ordinary circumstances, it is not easy to ascertain; but on the approach of evening, or when exhausted by their journey, nothing can prevent them from alighting. They will then descend even on the seas and rivers, of which some striking instances are recorded.

When a swarm has actually alighted, the means employed to drive them off are much the same as those to prevent their descent. But this is never attempted in wet weather, or until the sun has absorbed the dew, as the locust is quite incapable of flying while its wings are wet. When the swarm is large, or when it has come down on cultivated grounds, no measure of destruction is practicable without sacrificing the produce; but when the depredators have been driven to waste grounds, or happened in the first instance to descend upon them, various modes of extirpation are resorted to, of which the following is most effective: a large trench is dug from three to four feet wide, and about the same depth; the off side is lined with people furnished with sticks and brooms, while others form a semi-circle, which encloses the extremities of the trench, and the troop of locusts, which are then driven into the grave intended for them by the clamorous noises we have already described. The party stationed on the other side push back such insects as attempt to escape at the edges, crush them with their sticks and brooms, and throw in the earth upon them.

These insect devastators have fortunately a great number of enemies. Birds, lizards, hogs, foxes, and even frogs, devour a great number; and a high wind, a cold rain, or a tempest, destroys millions of them. In the east they are used as an article of food. In some parts they are dried and pounded, and a sort of bread is made, which is of much utility in bad harvests. They are sold as common eatables in the bazaar of Bagdad, and the cooks of the east have various ways of preparing them for use.—[Penny Magazine.]

Chaptal.—This distinguished chemist and statesman was a successful husbandman.

"When, shortly afterwards, he retired to private life, he again devoted his time to studies. In the beet manufacture, he spent a large portion of his fortune, and he fed a large number of animals, as, for instance, 1,200 merino sheep, of the finest wool, with the residue of the beets. He increased, by his agronomical improvements, the value of his property so much, that the nett proceeds, which were fourteen thousand francs amounted afterwards to sixty thousand."

A Cheap Method of making Fence of a Durable Character. By L. M. T. [From the New-York Farmer.]

If the ground be inclined in a direction opposite to that of the fence, begin by turning three or four furrows with a side-hill plough down hill; let them be thrown by the spade up the hill; plough three or four more on the same ground, and let them be thrown above the others; the ground will then present this shape—

Pick up your paving stones, if you have no better, or quarry about half as many as are requisite to make an ordinary 3½ feet wall, and place them against the bank formed until you have a fence four feet high, and from nine to fifteen inches thick, and what is better, one which will not fall down, and which has been tested by the writer of this article to resist the frost, when all other methods of making stone walls have failed. The bank must incline one foot in the four, or four and a half, of height. This fence is made at less expense by one-half of stone, and one-third of ordinary wall in the price of laying. If designed to stop sheep, it must be staked and sided in this shape—

The same fence can be made on level ground, and has been by myself, when it will present nearly the above profile, staked and sided, and is effective against both sheep and cattle. L. M. T.

Hoosick, Rensselaer co., March 21, 1834.

Years.—The word Year is purely Saxon, and is supposed by some to be derived from *era:* whilst others deduce both words from the Greek *ear*, or Latin *ver* (Spring); because many of the ancients were in the habit of dating the commencement of the year from spring. In the Hebrew, Greek, and Latin languages, the word *year* is expressive of a ring or circle. The Egyptians also represented it by a snake placed in a *circular* position, with its tail in its mouth; whence, perhaps the name of the *Zodiac*, or that *imaginary* circle which is made by the sun in the heavens, during the twelve months. The time in which the sun performs its journey through the twelve *signs* of the Zodiac comprehends 365 days, 5 hours, 48 minutes, and 48 seconds, and is therefore styled the Natural, Solar, or Tropical Year. The Sidereal, or Astral year, is the time which elapses from the sun's passage from any particular fixed star, until its return to it again, and is just twenty minutes and twenty-nine seconds longer than the natural or solar year. The Lunar year consists of twelve lunar months, or that period during which the moon passes twelve times through its various phases, or changes. The common or civil year, in use with us and established by law, contains 365 days during *three successive years*, but in each *fourth* year an *intercalary* or additional day is inserted, in order to make up the number 366, such additional day being considered equivalent to the time lost by not counting the five hours and forty-nine minutes at the end of each of the four years, from one Bissextile or Leap year to another. The word *leap* sufficiently explains the act of passing over the hours in question. This plan was invented by Julius Cæsar, or by Sosigenes, the Egyptian mathematician, who assisted him in rectifying the Calendar. The additional or *intercalary* day is with us always placed in the month of February, which consequently in *Leap Year* consists of twenty-nine days, the usual number being twenty-eight. Cæsar placed it in the month of March, by reckoning the sixth day of the calends of that month *twice over*, hence the term *Bissextile*, from the words *bis* (twice) and *sex* (six), or *sextilis* (sixth day). But by the Gregorian alteration, the fourth year coming at the close of a century is not a leap year, unless the number of hundreds be a multiple of four. Thus 1600 was a leap year, 1700 and 1800 were not, 2000 will be. The reckoning of time by the course of the sun or moon was attempted in various ways by different ancient nations; but they, finding that their minor divisions of time did not correspond with the courses in question, endeavored to prevent confusion by ordaining a certain number of days to be *intercalated*, or inserted, out of the common order, so as to preserve the equation of time. The *Egyptian* year (as used by Ptolemy) consisted of 365 days, which were divided into twelve months of thirty days each, besides five *intercalary* days at the end. The Egyptian *Canicular*, or *natural* year, was computed from one *heliacal* rising of the star Sirius, or *Canicula*, to the next. By the regulation of Solon, the ancient *Greek* year was *lunar*, and consisted of twelve months; each containing thirty and twenty-nine days, alternately; and, in every revolution of nineteen years, the third, fifth, eighth, eleventh, sixteenth, and nineteenth, it had an *intercalary* month, in order to keep the New and Full Moons to the same seasons of the year.

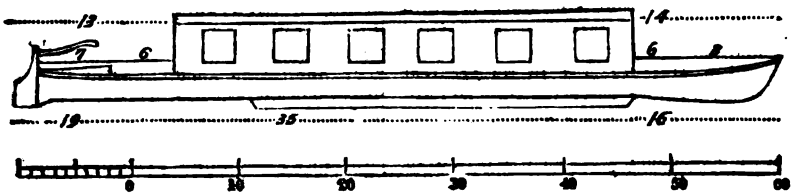
The ancient *Jewish* year was the same as the Greek one, only that it was made to agree with the Solar year by adding eleven and sometimes twelve days at the end; or an *intercalary* month when necessary. The modern *Jewish* year consists of twelve lunar months generally; but sometimes of thirteen, that is, when an *intercalary* month is inserted. The *Turkish* year consists of twelve lunar months of thirty and twenty-nine days alternately, sometimes of thirteen. The ancient *Roman* year, as settled by Romulus, was *lunar*, but contained only ten months, which were irregular, and comprehended 304 days in all; being a number fifty days short of the true *lunar* year, and sixty-one days of the *solar*. Romulus added the requisite number of days at the end of the year. Numa Pompilius added two months, making the year to consist of 355 days, thereby exceeding the *lunar* year by one day, but being short of the *solar* one by ten days. Julius Cæsar, during his third consulship, and whilst he was Pontifex Maximus, or high priest of Rome, reformed the calendar by regulating the months according to their present measure, and adding an intercalary day every fourth year to the month of February; but he being assassinated before his plan could be fully brought into operation, the Emperor Augustus perfected and established what his kinsman had begun. The *Julian* year, which consisted of 365 days and 6 hours, was, however, still incorrect; for it was found to be too long by about 11 minutes, which in 181 years would be equal to one day; consequently, there was a further reformation of the calendar by Pope Gregory, in the 1582. He cut off eleven days, by calling the fourth of October the fifteenth. This alteration of the *style* was gradually adopted in the several countries of the European continent; but in Russia, in some of the Swiss cantons, and in the countries of the East, the *old style* is still preserved. The Parliament of England adopted the *Gregorian* plan, in 1752, by enacting that eleven days should be *omitted* that year, all dates therefore, previous to 1752, are said to be according to the Old Style: whilst those since that period are deemed to be according to the New Style. In 1800, which was properly a bissextile, or leap year, the intercalary day was omitted; hence the difference between the old and new style is now twelve days. The *Gregorian* regulation does not absolutely preclude all error in future; but that is likely to be so trifling, as not to require particular attention. The beginning of the year has by no means been the same in different ages and countries. The Chaldeans, the Egyptians, and the Jews, in all civil affairs, began it at the *autumnal equinox*. The ecclesiastical year among the Jews, the common year of the Persians, and of the Romans under Romulus, commenced in spring: a mode still followed in many of the Italian states. Both the *equinoxes*, as well as the *summer solstice*, were each the commencing date in some of the states of Greece. The Roman year, from the time of Numa, began on the calends of January; the Arabs and Turks compute from the 16th of July; the christian clergy formerly commenced the year on the 25th of March *—a method observed in Great Britain, generally, in civil affairs, until 1752; from which period our civil year has begun on the 1st of January, except in some few cases, in which it still commences on the "Day of Annunciation," or the 25th of March. In Scotland, the year was, by a proclamation, bearing date so early as the 27th of November, 1599, ordered thenceforth to commence in that kingdom on the 1st of January, instead of the 25th of March. The English Church, still, in her solemn service, renews the year on the *First Sunday in Advent*, which is always that next to or on *St. Andrew's Day*. Our ancestors, after the establishment of Christianity, usually began their year at *Christmas*, and reckoned the commencement of their *æra* from the incarnation, or birth of Christ. William the Conqueror, however, introduced the method of substituting the first year of his own reign for the Christian æra. At subsequent periods, the English reverted to the ancient custom; but all State proclamations, patents, charters, and acts of Parliament, have continued to be dated from the commencement of the reigns of the respective sovereigns, with the addition of the words, "and in the year of our Lord," &c. The Russian government did not adopt the Christian æra until the time of Peter, in 1725; their previous practice had been to reckon from the world's age, or the *year of the creation*.

The Paisley Canal Passage-Boats. By James Whitlaw. [From the London Mechanics' Magazine.]

Sir,—As your correspondents have been requested to forward to you information respecting the light gig-shaped boats lately introduced upon canals, I send you the following account of the Paisley canal passage-boats, from which account I think it will be seen that the *skiffing*, or *rising to the surface of the water principle*, so much insisted on by Mr. Macneill, has little to do with their quick rate of sailing.

Description of one of the Boats.—The length is 70 feet, width 6 feet, and 1 foot 10 inches is the depth. With ninety passengers, which is as many as a boat can conveniently take, the draught of water is 19½ inches; when all the passengers are out, the draught is only 5½ inches. The rudder is 2 feet long and 20 inches deep, and its bottom is in a line with the under side of the keel. The weight of the iron work is 17 cwt.; and the weight when the boat is finished is 33 cwt. The following figure is a side view of one of the boats. The windows in front light the cabin, and those behind are for the steerage. The part at the bow marked 6 feet is a deck for the passengers, and the part marked 6 feet has seats round it. The 6 feet towards the stern is for the same purpose as the 6 feet in front, and the 7 feet is a deck on which the steersman stands; under each

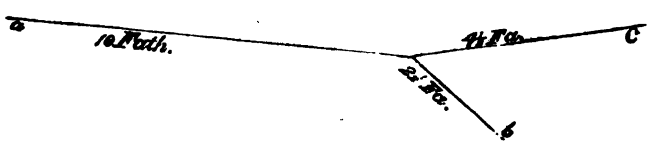
* The Church of Rome dated from the Sunday succeeding the full moon which occurred next after the vernal equinox; or, if the full moon happened on a Sunday, the new year commenced on that day.



deck is a place for any light luggage. The keel is 35 feet long; the part in front (under the boat) marked 16 feet, and that behind, marked 19 feet, have no keel—this allows the boat to turn quicker. A line stretched from the highest point in the bow to the highest point in the stern would rise about 6 inches above the lowest part of the gunnel. The depth of the keel is 5 inches; and this depth did not form part of the measures given above, of the draught of water, and the depth of the boat. The plates are of 16th wire-gauge. The ribs are made of light gunnel-iron; and a rim of the same goes round the inside of the top edge of the boat, on which the wooden gunnel is fixed by means of square-headed screws. There are light ribs of wood laid inside of the boat, on which the flooring is nailed, and a broad stripe of wood runs between the seats and the windows, so high that the passengers may rest their backs upon it. The cotton oiled cloth, which covers the cabin and steerage, requires three very thin coats of boiled oil to make it water-tight, and it should be dried in the sun if possible: very light curved ribs, set about two feet apart, support the cloth overhead, and it is fixed to the frames of the windows, &c., at the sides of the boat. A boat of this kind can be finished in a most comfortable style for £130. The cost of the iron-work is £70, and £60 will pay the joiner and other work of the boat.

The hooks (there is one on each side), on which the towing-line is fixed, are fastened to the gunnel of the boat at about 15 feet from the bow; the rope is put on one of these, when the boat is not very much loaded, but when there are a great many passengers, the rope is fixed about 3 feet 6 inches nearer the bow; this helps the boat round the turns on the canal. The shape of the hook is as represented in the following sketch, to prevent the rope, any time it slacks, from falling off.

As the Paisley canal is a very winding one, the longest towing-line that can be used on it is as follows:



a, is the end connected to the boat; *b*, is fixed to the one horse, and *c*, to the other. If the rope were longer than this, it would draw the boat against the side, at a quick bend on the canal. The horse in front has blinders on it, and a boy rides on the one behind. The harness must be as light as possible. If the horses are run 12 miles a day, they keep in excellent order, but 16 miles per day is too much for them. The horses are changed every 4 miles. Half blood horses, or a breed between half blood and full blood, answer best.

The canal is 30 feet wide, except at the bridges, where it is only 11 feet, and there are two or three more contracted places on it, of considerable length. The average depth of the canal is 4 feet 6 inches. The sides of the canal are lined by a *perpendicular wall*, built of small stones, which goes 10 or 11 inches below the surface of the water, and as much above it. The distance from Glasgow to Paisley is 7¼ miles by the canal, and the distance from Glasgow to Johnstone is more than 11 miles. The boats run the distance between Glasgow and Paisley in 50 minutes, and take in and put out a good many passengers at different places on the way; and the distance from Paisley to Johnstone is run over in a time proportionably short. The cabin fare is 9d., and the steerage fare is 6d., from Glasgow to Paisley. When passengers go from Glasgow to Johnstone, they are charged 1s. in the cabin, and 9d. in the steerage.

The best speed for the Paisley canal boats is greater than 9 miles an hour; and this velocity occasions a very little and gradual swell, not more than 7 inches high on the canal; there is no wave whatever at or before the bow of the boat, and the water is lower than the surface of the canal just behind the bow; it then begins to rise, and the wave reaches its maximum elevation at about two-thirds of the length of the boat from its bow; at the stern the elevation of the wave is nothing, and any ripple that follows the boat is occasioned by the action of the rudder to turn the boat. At the best velocity the horses have not a heavy pull; but when the boat is drawn so slow as 6 or 7 miles an hour, the strain on the towing-line is very great, and waves rise in front of the boat more than 18 inches high, and wash over the banks of the canal. On account of the boat's being

so light, it may be brought from its maximum speed to a state of rest without raising a wave in front; and for the same reason it may be brought from a state of rest to its greatest speed before a very high wave has time to rise. At the bridges the wave at the side of the boat is rather more than 9 inches high when the boat is going at its best velocity; and when two of the boats pass each other at a quick rate, the wave is not worse than this. When two boats pass, the horses of one of them stop just before they come opposite the horses of the other boat, and a boatman takes the tow-line off its hook and holds it, in case it should come in contact with the bottom of the other boat, which is passing it at its full speed. As far as I know, no accident has happened since these boats have been put upon the canal, and the trade has increased very much.

When the speed of the boat is low, the waves rise and get a great way ahead of it; if the velocity is increased to a certain extent, the boat keeps up to the wave; and if it sail quicker still, the bow gets before the swell, which decreases in height as the velocity of the boat increases —in the highest velocities, at least, that I have seen the boat brought up to. From this it would appear that the wave has a determinate velocity, like the undulations that cause sound —at any rate, it has a maximum velocity: and if the whole cause of the formation of the wave continues when the boat goes quicker than its motion, the wave will fall behind. Now, there is a vacuum formed towards the stern of every vessel when it is sailing; this, together with the height at which the wave stands above the level of the canal, and the motion of the wave in the direction of the boat, will cause it (the wave) to fall in towards the stern of the vessel, and act on its inclined sides, giving back a great part of the power spent in its formation, if the vessel is properly formed. The water sent towards the sides of the canal by the inclination of the bow, will be reflected from the perpendicular facing on the banks, and act in the same way. The *lateral communication of motion* among particles going in different directions may have a tendency to keep down the swell. If this explanation is correct, the boats must have their dimensions and form corresponding to the width of the canal, and the velocity they are to sail at.

As the boat *rises* on the wave, its bow is up or down, according as the wave is fore or aft.

I am, Sir, yours, &c.

James Whitlaw.

Illuminated Printing.—In many of the old printed books, the initial letters, and occasionally other parts, were printed in red. This was done by two workings at press, and was an imitation of the earlier fashion of *illuminating* manuscripts. The practice is still followed in some almanacs, the saints' days and holy-days being "red-letter days." Some ingenious contrivances have been devised for working in various colors; and a few years since, a curious book was written and published on the subject by Mr. Savage. Still more recently, printing in gold and other metals has been practised. This is done by printing with a sort of size, and afterwards applying the metal leaf. Some very handsome specimens of this have been produced by Messrs. Howlett and Brimmer, of London; but, of course, the process is too costly and too tedious ever to enter into competition with common printing, or to be used for other than purposes of luxury.

Valuable Discovery in the Fine Arts.—Mr. Mudie, well known as an able literary compiler, has brought out a popular work on "the feathered tribes of the British Island," in which, amongst other attractive features, the vignettes on the title pages are novelties, being the first successful specimen (says Mr. Mudie) of what may be called Polycromatic printing, or printing in many colors from wooden blocks.

"By this method," he adds, "every shade of color, every breath of tint, every delicacy of hatching, and every degree of evanescence in the outline, can be obtained; and fifty thousand fac similes of a painting may be produced with perfect uniformity and at moderate expense. The advantages to books, of which a large number is to be sold, will be very great, not only as removing the cost of tinging by hand, which is the same for the last thousand as the first, but by making the copies more alike and more durable, and rising more above the reach of the ignoble pecus of imitators. In these vignettes, Mr. Baxter had no colored copy but the birds, which are from nature. I made him work from mere scratches in outline, in order to test his metal; and I feel confident that the public will agree with me in thinking it sterling. In carrying this very beautiful branch of the typographical art successfully into effect, Mr. B. has, I believe, completed what was the last project of the great Bewick, but which that truly original and admirable genius did not live to accomplish."

The Pulse.—Every one knows that among the numerous inquiries and examinations which precede the prescription of a careful physician, the state of the pulse is never omitted; yet, as it is probable that few of our readers are acquainted with the reasons for this inquiry, or, what is the same thing, with the facts to be learned from it, we think it may not be uninteresting if we enumerate some of the more prominent ones.

It is almost unnecessary to premise that by the pulse is meant the beat of an artery, and that the one commonly chosen for examination is the radial artery, which beats at the wrist. The first point generally attended to is the number of the beats; and since in this, as in all other medical questions, it is necessary to be acquainted with the state of health, in order to recognize any deviation from it, we must mention the ordinary frequency of the pulse at different ages. In the new-born infant, it is from 130 to 140 in a minute; but decreases in frequency as life advances; so that, in a middle-aged adult in perfect health, it is from 72 to 75. In the decline of life, it is slower than this, and

falls to about 60. It is obvious that if we could suppose a practitioner ignorant of these plain facts, he would be liable to make the most absurd blunders, and might imagine a boy of ten to be laboring under some grievous disease, because his pulse had not the slow sobriety of his grandfather's. A more likely error is to mistake the influence of some temporary cause for the effect of a more permanent disease: thus, in a nervous patient, the doctor's knock at the door will quicken the pulse some 15 or 20 beats in a minute. This fact did not escape the notice of the sagacious Celsus, who says, "The pulse will be altered by the approach of the physician, and the anxiety of the patient doubting what his opinion of the case may be. For this reason, a skilful physician will not feel the pulse as soon as he comes; but he will first sit down with a cheerful countenance, and ask how the patient is,—soothing him, if he be timorous, by the kindness of his conversation, and afterwards applying his hand to the patient's arm."—(De Medica, lib. iii. cap. 7.*)

Granting, however, that these sources of error are avoided, the quickness of the pulse will afford most important information. If in a person, for example, whose pulse is usually 72, the beats rise in number to 96, some alarming disease is certainly present; or, on the other hand, should it have permanently sunk to 50, it is but too probable that the source of the circulation, the heart itself, is laboring under incurable disease, or that some other of the great springs of life is irremediably injured.

Supposing, again, the pulse to be 72, each beat ought to occur at an interval of five-sixths of a second; but should any deviation from this rhythm be perceived, the pulse is then said to be irregular. The varieties of irregularity are infinite; but there is one so remarkable as to deserve particular mention. It will happen sometimes that the interval between the two beats is so much longer than was expected, that it would seem that one beat had been omitted: in this case the pulse is said to be an intermittent one. When the action of the heart is irregular, the beat of the pulse is so likewise; but it will occasionally happen that the latter irregularity takes place without the former one, from some morbid cause existing between the heart and the wrist. It is hardly necessary to observe, that, in all doubtful cases, the physician examines the pulsation of the heart as well as that of the wrist,—just as the diligent student, discontented with the narrow limits of provincial information, repairs to the metropolis to pursue his scientific inquiries.

The strength or feebleness of the pulse, its hardness or softness, and innumerable other qualities, might be discussed here; but, from the great difficulty attending any examination of these points, and the technical niceties involved in any thing more than a bare mention of them, we omit them. There is one point, however, which it would be unpardonable to pass over in silence: sometimes no pulsation can be felt at the usual part of the wrist. This may proceed from so great a languor of the circulation, that it is imperceptible at the extremities; or from the radial artery (the one usually felt) being ossified; or from an irregular distribution of the arteries of the fore-arm.

* The lapse of eighteen centuries has not destroyed the utility, much less the beauty, of the eight books on Medicine bequeathed by Celsus to posterity; they are unrivalled for perspicuous elegance and laconic good sense. Celsus is one of the writers of the Augustan age, and is worthy of the times in which he flourished.

Effect of Oil on Water.—The following is a secret worth knowing: In rough weather they (the fishermen of the Bosphorus) spread a few drops of oil on the surface, which permits them to see clearly to a great depth. I was aware that oil would calm the surface of the sea; but until recently I did not know that it rendered objects more distinct beneath the surface. A trinket of some value had been dropped out of one of the upper windows of our palace into the Bosphorus, which at this place was 10 or 12 feet deep. It was so small that dragging for it would have been perfectly useless, and it was accordingly given up for lost, when one of the servants proposed to drop a little oil on the surface. This was acceded to, with, however, but faint hopes of success. To our astonishment, the trinket immediately appeared in sight, and was eventually recovered.—[Dr. Dekay.]

Vegetable Silk.—There is at present considerable activity in a new branch of industry at Paris. We allude to the manufacture of carpets, and various other articles of general use, from a substance first imported into France by M. Pavy, to which he has given the name of vegetable silk. This substance has, in fact, an appearance very similar to that of silk, and can be employed as its substitute in a variety of cases. It is white, and can receive dye of any color. This vegetable is gathered in shoots of from 15 to 20 feet in length, and is of such strength that four of its shoots plaited together will bear a weight of 40 pounds.—[Balt. Gaz.]

Steam Carriages.—The select committee appointed last session of Parliament, on the motion of Colonel Torrens, conclude their report with the following summary of the result of their inquiries:—1. That carriages can be propelled by steam on common roads, at an average rate of ten miles per hour. 2. That at this rate they have conveyed upwards of fourteen passengers. 3. That their weight, including engine, fuel, water, and attendants, may be under three tons. 4. That they can ascend and descend hills of considerable inclination with facility and ease. 5. That they are perfectly safe for passengers. 6. That they are not (or need not be, if properly constructed,) nuisances to the public. 7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses. 8. That as they admit of greater breadth of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will

cause less wear of roads than coaches drawn by horses. 9. That rates of toll have been imposed on steam-carriages which would prohibit their being used on several lines of road, were such charges permitted to remain unaltered.—[New Monthly Magazine.]

Harlaem Railroad.—One of the most interesting rides which both citizens and strangers can take in this city, is that on this railroad. For 12½ cents, a ride of five miles to Yorkville is obtained. It is true that the route affords no beautiful view of cultivated fields and gardens, but conveys an idea of the great amount of labor bestowed in cutting the track through hills of solid rock from 20 to 60 feet high, affording a correct idea of the geological structure of the island. At the termination of the ride is a spacious hotel, on very elevated ground, affording one of the most extensive, varied, and richest prospects to be seen in our country.

Inland Navigation.—From the New-York Observer, we make an extract from the proceedings at the recent anniversary of the Seamen's Friend Society.

Mr. Peet, in moving the second resolution, presented an interesting statistical view of the canals, rivers, lakes, and inland navigation, of the great west. In New-York alone, he said, the canals now completed and in operation extend 500 miles through a populous country, having on their banks 100 villages and cities, and bearing on their bosom 1,800 boats, navigated by between 10 and 12,000 men. The great lakes were also navigated by numerous large vessels, the number on lake Erie alone being 170, including 30 steamboats. Passing through these lakes, and the Ohio canal, on which the number of boats and boatmen is increasing with great rapidity, we come to the river Ohio, which stretches a thousand miles through a fine country to the Mississippi, the father of rivers, with its twenty-three tributaries, affording navigation for 8000 miles in various directions. The whole line of inland navigation in the United States, including canals, rivers, and lakes, Mr. P. estimated at 20,000 miles, and the whole number of boats employed on these waters at between 6 and 7,000, viz. 4,000 flat boats, 2,000 canal boats, between 3 and 400 steamboats, and 200 sloops and schooners. The number of men employed in inland navigation is 60 or 70,000, and the number of passengers transported annually is more than 200,000.

Railroads in Tennessee.—Extract of a letter to the Editor of the Railroad Journal, dated

Nashville, May 2, 1834.

Dear Sir,—A constant employment during all the winter, in reconnoitering different routes for railroads in the western part of the State of Tennessee, prevented me from giving you any account of the situation of the internal improvements in that State. The companies being now organized, the officers elected, and the stock subscribed, I take the advantage of my first leisure hour to send you my two reports to the stockholders of the Jackson and Columbia Companies.

In January last, stock to the amount of $500,000 was subscribed for a line of railroad to the Mississippi river, and in March a like subscription was made for another line, in the same direction, from Columbia, Maury county, to the Tennesee river; and as, by the charter of the Jackson Company, they have a right to extend their road in the western districts, increasing the stock to the amount of one million of dollars, the two roads will be soon connected by an intermediate line.

I examined all the country, and furnished the companies with estimates of the probable cost of the work, and it is on account of those reports that the stock has been so liberally subscribed. In Jackson the commissioners were obliged to strike out $430,000, the amount subscribed over the capital of the Company, thereby reducing the subscription of the largest stockholders to 159 shares each.

East Tennessee has had a charter for a railroad since 1831, and is now making preparation to join the west in improving the internal communication of the State; and I can assure you, that within 6 or 7 years an uninterrupted communication will be opened between New-York and New-Orleans, either by the Valley of the Clinch, through Abingdon, Virginia, joining the Petersburg railroad, or through the Valley of the French Broad, by Ashville, North Carolina, joining Athens, Georgia, or Hamburgh, South Carolina, by which the mail will be carried over the route in 5 or 6 days.

A railroad through the centre of the State of Tennessee will be of inestimable advantage, not only to that State, but to the whole Union, as it will be the great rendezvous of all the emigrants to the Valley of the Mississippi, affording a speedy and easy transportation; opening the markets of the north-east and southwest for the products of her rich soil and mild climate, so well calculated for wheat, hemp, tobacco, and cotton; and also for her inexhaustible quarries of marble, beds of coal, and veins of ore of every metal, found amongst her beautiful and picturesque mountains.

I am sincerely yours, &c.

J. B. Petitval, Civil Engineer.

Railroad across the Isthmus of Panama.—A subscription of $90,800 had been made in Panama for the construction of a railroad from Porto-Bello to Panama, i. e. from the Pacific to the Atlantic. The speedy achievement of the undertaking was considered certain. A gentleman by the name of Ventura Marrouin, has discovered a passage from Cruces to Porto-Bello, i. e. from sea to sea, in a great measure free from hills, which can be accomplished, and which he has actually accomplished, in *less than one day*. The paper before us anticipates immense advantages from this discovery, and says it will be one of the most splendid triumphs which the Isthmus could achieve for commerce and civilization. The authorities of Panama had sent a commission, accompanied by Mr. Marrouin, to explore more fully the route referred to.—[Jour. of Com.]

DRY ROT.—An officer of the navy, now dead, was informed by the Rev. G. Williams, of Rhicolos, in North Wales, that it had been found, from long experience, that the water in the reservoirs for supplying the precipitate pits at the copper-mine works at Parry's mountain, in Anglesea, has the property of preserving timber from decay and dry rot in a surprising manner, by the short process of steeping it therein a few weeks only, and that it has such a powerful effect in hardening the wood as to blunt the sharpest tools. It, consequently, is found necessary to shape and fit the wood completely for the use intended, before it is put into this water for seasoning.

The water at Parry's mine is impregnated with copper, sulphuric and vitriolic acids. It is preserved in large reservoirs for supplying the precipitate pits, which are filled with old iron, that attracts the copper from the water.

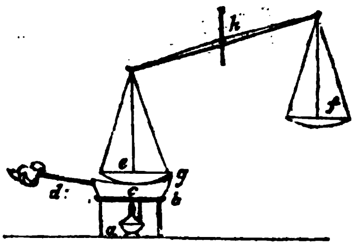
It appears that the farmers, when they find their timber for agricultural purposes too green for immediate use, steep it for a few days in the copper-water, which has the power of extracting the sap, and fitting it for use properly seasoned.

I understand that a complete transmutation takes place in the iron: it gradually becomes incrusted with the copper, whilst at the same time the acids act as a corrodent; so that a piece of iron thrown in, after a certain time, comes out copper, but whether weight for weight, or size for size, I do not recollect.

The Admiralty, I believe, are in the possession of this information; if, however, the present method of immersing ships and timber in sea-water is successful in curing or preventing the dry rot, we certainly cannot obtain a more easy or cheap method for gaining the desired end. The component parts of sea-water, common salt, marine magnesia, and salenite, are very dissimilar to those of the mineral waters of Parry's mine, and it will be curious if both, nevertheless, produce the same effect upon wood.—[U. S. Journal.]

MATERIALS FOR PAPER.—By a series of experiments I have ascertained that *paper*, of an excellent quality, can be prepared, not only from the husks of Indian corn, but also from a pulp made from various kinds of wood and bark, particularly from the bark of several kinds of poplar, and from the wood of birch and some other trees. In conducting my experiments, my plan has been first to select the vegetable matter; then, if it required whitening, to bleach it in chlorine gas, and afterwards to reduce it to a fine pulp, by pounding, and filing in water. When properly prepared, I would place a small portion of the pulp between polished steel plates, slightly warmed, and strongly compress them by screw power; the degree of consistency and polish assumed by the pulp, under such compression, would indicate the quality of paper capable of being prepared from the vegetable matter used. I trust that the time will soon arrive, when rags will not be considered as indispensable in the manufacture of paper, and will be, when economy or convenience requires it, superseded by different kinds of vegetable substances, which are so cheaply, bountifully, and universally furnished by nature.—[Eng. pap.]

TESTS OF THE TEXTURE OF SOILS.—One of the best methods of ascertaining the capability of any soil to take up and retain moisture is that described by Mr. C. Johnson, for which purpose he employs the following apparatus.



a, is a small lamp; *b*, a stool, with a hole in the seat for receiving *c*, a shallow tin vessel, closely covered, but having a pipe, *d*, for the escape of steam; *h* is a pair of accurate scales, such as are used by apothecaries and goldsmiths. In order to employ this apparatus, put a small quantity of the soil to be tried upon the top of the tin vessel, in which water is kept briskly boiling for about half an hour, so as to thoroughly dry the soil by expelling its moisture. Take ten grains accurately weighed of this dried soil, and add to it, by means of a quill, a drop or two of pure water; if distilled water can be had, so much the better. Weigh the whole a second time, which will now be a few grains above ten. Take out the weight of the water from the scale, leaving in the weights of the dried soil, and suspend the beam, so that the scale *e* may rest on the lid of the tin vessel, the water in which it is still kept boiling; then with a stop-watch note the exact time which the added water takes to evaporate, as will be shown by the beam of the balance becoming level. Mr. Johnson found, that soils requiring less than twenty-five, or more than fifty minutes, to evaporate the added water, and bring the balance to a level, were always proportionally unproductive; the first, from having too much flinty sand, and consequently too few interstices to allow the water to escape.

Rich soil, treated in this way, required thirty-two minutes to bring the beam to a level; chalk, twenty-nine minutes; poor flinty soil, twenty-three minutes; and gypsum, only eighteen minutes.

A very fertile soil from Ormiston, Haddingtonshire, containing, in 1000 parts, more than half of finely-divided materials, among which were eleven parts of limestone soil, and nine parts of vegetable principles, when dried in a similar way, gained eighteen grains in an hour, by exposure to moist air, at the heat of sixty-eight degrees Fahrenheit; while 1000 parts of a barren soil, from Bagshot Heath, gained only three grains in the same time.

Mr. Johnson farther found that one hundred parts of burnt clay, when exposed in a dry state for three hours to air saturated with moisture at sixty-eight degrees, took up twenty-nine

parts of water; that gypsum, in similar circumstances, took up only nine parts, and chalk only four parts.

Another method of testing the texture of soils is by taking what is termed their specific gravity; that is, comparing what they weigh in air with what they weigh in water. Sufficient accuracy for practical purposes may be obtained by drying two different soils, at an equal distance from a fire, or in an oven, at the same time, and then weighing in the air a pound of each in a thin bladder with a few holes near its top, or neck. When the weight has thus been obtained in the air, the bladder may be put into water, letting it sink low enough to permit the water to enter through the holes in the neck, in order to mix with the dried specimen of the soil. The weight in water, divided by the difference of the two weights, will be the specific gravity, and the less this is, the greater will be the capacity of the soil to take up and retain water. Muschenbroek thus found rich garden mould to be 1630 compared to 1000 of water, and Fabroni found a barren sand to be 2210 compared to 1000 of water.

Or fill a wide necked pint or quart bottle half full with water, and add the soil to be tried till the water rises to the brim. Then if the bottle can contain one pound of water, and gains half a pound additional when filled in this way, half with water and half with soil, the soil thus tried will be twice as heavy as water, and its specific gravity will be two. If it only gain a quarter of a pound, its specific gravity will only be one.

M. Giobert ascertained that a pound of fertile soil contained, of flinty sand, about 4,400 grains, of clay about 600 grains, of lime about 400, besides seventy of water, and about twenty-five grains of inflammable materials, chiefly carbon. On a comparative trial of a barren soil, M. Giobert found that a pound weight contained about 600 grains of clay, about 400 grains of lime, and little or no inflammable materials. Mr. Grisenthwaite directs an equal portion of two soils, perfectly dry, to be introduced into two tall glasses, in the midst of each of which a glass funnel has been previously placed. The soils are to be put in so as to retain, as nearly as possible, their natural state when in the ground, and are consequently not to be too much pressed down. When this has been done, water is to be poured very gradually into each of the funnels, and it will rise up as it does in a piece of lump sugar into the dry soil, as may be seen through the glass. The more rapidly the water is seen to rise, the better will be the texture of the soils.—[Professor Rennie.]

Patent for a Thrashing Machine: James Hart, and Waller S. Holladay, Spottsylvania, Va., September 17.

This patent is taken for the manner of constructing the cylinder and concave, which is as follows: A square bar of iron is to form the shaft of the cylinder; the gudgeons, of course, being rounded. Flat bars of iron, from sixteen inches to two feet in length, are to have square holes made through their centres, so that they will slip on to the shaft. One of them is to be put on, and against it a circular piece of plank, four inches less in diameter than the length of the bar, leaving the latter to project two inches, to form teeth, or beaters; the plank, by its thickness, regulating the distance of the teeth. A second bar is to be placed against this plank, at right angles to the former, then another plank and another bar, until there are enough for the length of the cylinder. For the sake of greater firmness the bars are let into the plank; and to keep the whole together, four screw bolts are to pass from end to end of the cylinder, through the plank and bars. The concave is to be placed above the cylinder, and to be formed of plank, with projecting teeth, on the same principle.

There is no claim made, but as the whole description consists in the manner of constructing the cylinder and concave, the object of the patent is sufficiently apparent.

Patent Thrashing Machine: Linus Yale, of Otsego, and Philo C. Curtis, of Utica, Oneida county, N. Y., September 17.

The concave is to be a semicircular trough of cast iron, supported on suitable legs, and having rows of teeth projecting from its interior. The cylinder is to be made by bending round, and brazing, or riveting, sheet iron of one-eighth of an inch in thickness. This is to be set with teeth of iron, or steel, and to have wooden or iron heads to receive a shaft, which revolves in boxes at the ends of the semicircular concave.

The claim is to the cast iron frame, the sheet iron cylinder, and the form of the spikes, or cogs, and manner of fastening them into the cylinder.

Anatomy of the Horse's Foot.—The horse, a native of extensive plains and steeps, is perfect in his structure as adapted to these his natural pasture grounds. When brought, however, into subjection, and running on our hard roads, his feet suffer from concussion. The value of the horse, so often impaired by lameness of the foot, has made that part an object of great interest; and I have it from an excellent professor of veterinary surgery to say, that he has never demonstrated the anatomy of the horse's foot without finding something new to admire. The weight and power of the animal require that he should have a foot in which strength and elasticity are combined. The elasticity is essentially necessary to prevent percussion in striking the ground; and it is attained here, through the united effect of the oblique position of the bones of the leg and foot —the yielding nature of the suspending ligament, and the expansibility of the crust or hoof. So much depends on the position of the pastern bones and coffin bone, that, judging by the length of these and their obliquity, it is impossible to say whether a horse goes easily, without mounting it. When the hoof is raised, it is smaller in its diameter, and the sole is concave; but when it bears on the ground it expands, the sole descends so as to become flat-

ter; and this expansion of the hoof laterally is necessary to the play of the whole structure of the foot. Hence it happens that if the shoe be nailed in such a manner as to prevent the hoof expanding, the whole interior contrivance for mobility and elasticity is lost. The foot in trotting comes down solid, it consequently suffers percussion; and from the injury, it becomes inflamed and hot. From this inflammation is generated a variety of diseases, which at length destroy all the beautiful provisions of the horse's foot for free and elastic motion. The subject is of such general interest, that I may venture on a little more detail. The elastic or suspending ligament spoken of above passes down from the back of the canon bone, along all the bones, to the lowest, the coffin bone; it yields and allows these bones to bend. Behind the ligament the great tendons run, and the most prolonged of these, that of the perforans muscle, is principally inserted into the coffin bone, having at the same time other attachments. Under the bones and tendon, at the sole of the foot, there is a soft elastic cushion; this cushion rests on the proper horny frog, that prominence of a triangular shape which is seen in the hollow of the sole. The soft elastic matter being pressed down shifts a little backwards, so that it expands the heels, at the same time that it bears on the frog, and presses out the lateral part of the crust. We perceive that there is a necessity for the bottom of the hoof being hollow or concave—first to prevent the delicate apparatus of the foot from being bruised, and, secondly, that elasticity may be obtained by its descent. We see that the expansion of the hoof and the descent of the sole are necessary to the play of the internal apparatus of the foot. That there is a relation between the internal structure and the covering, whether it be the nail, or crust, or hoof, we can hardly doubt; and an unexpected proof of this offers itself in the horse. There are some very rare instances of a horse having digital extremities. According to Suetonius, there was such an animal in the stables of Cæsar; another was in the possession of Leo X.; and Geoffrey St. Hilaire, in addition to those, says, that he has seen a horse with three toes on the fore foot, and four on the hind foot.* These instances of deviation in the natural structure of the bones were accompanied with a corresponding change in the coverings—the toes had nails, not hoofs. By these examples it is made to appear still more distinctly, that there is a relation between the internal configuration of the toes and their coverings; that when there are five toes complete in their bones, they are provided with perfect nails—when two toes represent the whole, as in the cleft foot of the ruminant, there are appropriate horny coverings—and that when the bones are joined to form the pastern bones and coffin bone, there is a hoof or crust, as in the horse, couagga, zebra, and ass. —[Bell's Bridgewater Treatise.]

* Such a horse was not long since exhibited in town and at Newmarket.

Oberlin Collegiate Institute.—We have given some notice of the origin and objects of this institution in a former number. From a recent circular we learn the following particulars.

The system embraces instruction in every department, from the Infant school to a Collegiate and Theological course. Physical and moral education are to receive particular attention. The institution was opened in December last, and has sixty students; about forty in the academic, and twenty in the primary department. All of them, whether male or female, rich or poor, are required to labor four hours daily. Male students are to be employed in agriculture, gardening, and some of the mechanic arts; females in housekeeping, useful needle-work, the manufacture of wool, the culture of silk, certain appropriate parts of gardening, &c. The Institution has five hundred acres of good land, of which, though a complete forest a year ago, about thirty acres are cleared, and sown with wheat. They have also a steam mill, and a saw mill, in operation. During the present year it is contemplated to add fifty acres to the cleared land, to erect a flouring mill, shingle machine, turning lathe, a work shop, with an extensive boarding house, (which together with the present buildings will accommodate about one hundred and sixty students,) furniture, farming, mechanic, and scientific apparatus; and begin a library.

During the winter months, the young men are at liberty to engage as agents, school teachers, or in any other occupation they may select. The expenses of students in the seminary for board at the table spread only with vegetable food, are eighty cents a week; and ninety-two cents a week for the same with animal food twice a day. Tuition is from fifteen to thirty-five cents a week. The avails of the students' labors have thus far varied from one to eight cents an hour. The average has been five cents. A majority of the male students have, by their four hours' daily labor, paid their board, fuel, lights, washing and mending, and some even more; and this without any interference with their progress in their studies.

The time to be spent at this Institution, in preparation for the various professions and employments of life, is not yet defined, nor a single course of study marked out as the only one through which an individual can attain a desired station. Diplomas are not to be given according to the time spent in study, but to the student's real acquirements.—[Annals of Education.]

We learn from the Annals of Education, that this plan of instruction is viewed very favorably in Georgia.

Power of Smelling in Birds.—A small pamphlet has been put into our hands by a friend, containing an account of some interesting experiments made at Charleston, South Carolina, during the winter, for the purpose of determining certain facts in the natural history

of the Vulture. The Turkey-Buzzard and the Carrion-Crow were the particular subjects of experiment, and the object was to determine whether they do in fact possess the extraordinary powers of smelling which have been so uniformly attributed to them by naturalists, and whether it is their habit to feed only on putrid meat.

Mr. Audubon was the first writer on American Ornithology, who denied the Vulture the faculty of smell, and maintained that it is guided by the eye only, in its search for food. The experiments by which he arrived at this opinion were published in 1826, and have been treated on both sides of the Atlantic, with severity, as unsatisfactory, and indeed palpably absurd. The pamphlet before us, written by Doctor Bachman, of Charleston, details a series of experiments, made for the express purpose of testing the correctness of Mr. Audubon's opinion. That gentleman was on a visit to Charleston, but took no part in them. They were witnessed by Robt. Henry, President of the College of South Carolina, Dr. John Wagner, Professor of Surgery of the Medical College of the State, Dr. Henry Frost, Professor of the Materia Medica, and C. F Leitner, Lecturer on Botany and Natural History, in the same institution, Dr. B. B. Strobel, and Martin Strobel, Esq. all gentlemen of eminent standing and capacity. They have unanimously signed a certificate, stating that from the experiments they have witnessed on the habits of the Vultures of Carolina, called the Turkey Buzzard and the Carrion Crow, they "feel assured they devour fresh as well as putrid food of any kind, and that they are guided to their food altogether through the sense of sight and not that of smell."

The result, besides its bearing on a material part of natural history, is a gratifying testimony to the scientific accuracy of Mr. Audubon, and a sufficient defence against the illiberal sneers with which his discovery has been treated. The experiments detailed show not only that those birds are without any particular strength of smell, but that they are destitute of the sense altogether. Among other proofs of this, it was found that they were attracted by coarse pictures of dead animals, and were unable to perceive flesh, which was only hidden by a piece of canvass, although standing upon it at the time. The experiments were varied in such a way as to make it impossible there should be any mistake. There can be no doubt that with respect to this part of the Vulture family, the opinions that have prevailed for so many centuries are erroneous.

Among the experiments was one to test the story, published lately,—that if the eye of the turkey-buzzard was put out by perforation, it would be restored, and the sight renewed by putting the head under the wing, the down of which was said to perform the miracle. They found that the ball of the eye is refilled, but the sight was not restored. They found, also, that a blind bird cannot perceive the most offensive animal substance, however near.—[Baltimore American.]

To increase the Strength and Firmness of Thread and Coarse Cloth.—The lixivium of oak has been employed for scarcely any other purpose than that of the tanner, and yet it is applicable to a great variety of uses. If thread, cords, nets, coarse linen, &c. be steeped in it, they acquire greater firmness and durability. Fishermen have long resorted to this. Nothing is more apt to spoil than skins, and yet this preserves them. It is the same with hempen and linen cloth: they contain much gummy and resinous matter, which, with tannin, forms an envelope, and thus adds to their durability. Linen ought not to steep more than eight or ten days in this solution: it acquires a very brown color. When this color fades, the operation may be repeated.

The best method of preserving nets and cordage is the following: Dissolve two pounds of Flemish glue in fifteen gallons of water, dip the nets, &c. into this solution, and then steep them in a strong solution of oak or chesnut bark,—the tannin combines with the gelatine, and forms, between the fibres of the hemp, a solid net work, which adds great strength to the cords. Any bark which contains tannin may be employed in making a decoction; so bones, parings of skin, remains of fish, &c. and generally all substances containing gelatine, may be used in making a gelatinous solution. Fishermen, who often throw away on the shore gelatinous fish, may use them for this purpose.—[Jour. des Connais. Usuelles.]

To temper Large Instruments.—W. H. Raiford, in the Southern Planter, says, some wrought-iron ploughs will last twice as long as others. This is owing, in a great measure, to the tempering. It is in vain, he says, to attempt to temper large instruments, in a small quantity of impure water. The more and the purer the water the better will be the temper.

To take out Ink from Mahogany.—Wet a piece of blotting paper, rolled into a ball, and rub the table with it. Afterwards rub the places where the ink was with a dry cloth.

Preservation of Skins.—J. Stegard, tanner at Tyman, in Hungary, completely preserves raw hides from putrefaction, and restores those that are tainted, by applying to them, with a brush, a layer of pyroligneous acid. They absorb it very speedily, and it occasions no injury nor diminution of their value.—[Receuil Industrielle.]

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*.—John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

MECHANICS' MAGAZINE,

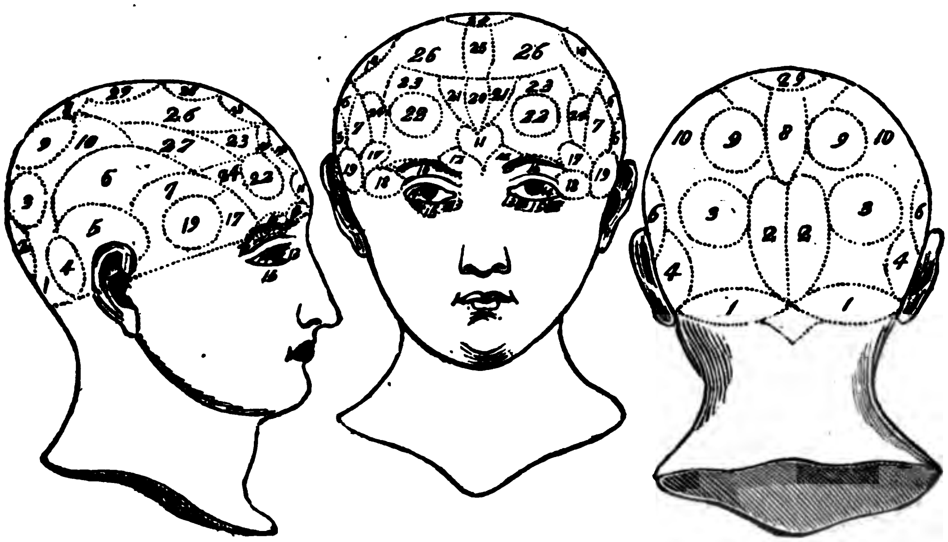
AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] JUNE, 1834. [NUMBER 6.

"Those who aim vigorously at perfection will come nearer to it than those whose business or despondency makes them give up its pursuit from the feeling of its being unattainable."—CHESTERFIELD.

PHRENOLOGY.



1. Organ of reproduction. Instinct of generation or of propagation. Venereal propensity. Physical love. Generative energy.

The cerebellum is the seat of this organ, which, fully developed, forms two prominences, one on each side of the head, behind and immediately above the neck. Then the back of the neck is large, the neck rounded, and the ears far apart.

2. Love of progeniture. Organ of maternity. Philogenesia. Maternal love. Love of children. Philoprogenitiveness.

This organ appears immediately above the preceding, on each side of the median line. When it is much developed, there results a projection on the posterior part of the head.

3. Organ of attachment and of friendship. Sympathy. Disposition to contract certain species of mania. (Nostalgia.)

The seat of this organ is found on a level with, and on the outside of, that of maternity. Like it, and that of propagation, it is double, and forms a protuberance on each side of the head.

4. Instinct of self-defence and of the defence of property. Organ of courage, disposition to quarrel and fight. Combativeness.

According to M. Gall, all quarrelsome persons have the head, immediately behind, and on a level with, the ears, much more prominent than poltroons.

5. Carnivorous instinct. Cruelty. Barbarity, sanguinary disposition, propensity to murder. Instinct of destruction. (Insensibility.)

In the tempero-parietal region, immediately above and behind the auditory canal, is found the prominence of this organ.

6. Organ of cunning, of finesse, of management. Instinct to conceal. Spirit of intrigue. Dissimulation. Lying. Duplicity. (Astuteness.)

The organ of cunning is a little above and before that of destructiveness. It is of an elongated form, and renders the head large above the temples.

7. Instinct of making provisions. Sentiment of property. Covetousness, propensity to steal. Theft. Usury. (Idea of *mine* and *thine*.)

This organ extends from that of cunning to within

a short distance of the external border of the supra-orbital or superciliary arch.

8. Organ of pride—propensity to elevate one's self. Propensity to inhabit certain places. Love of authority. Haughtiness. Domination.

The seat of this instinct is found on the median line, or in the middle of the head, a little beneath and behind the summit of the head.

9. Love of approbation, of glory, and of distinction. Ambition. Vanity. Point of honor. Coquetry. Ostentation. Emulation. Jealousy.

On each side of the elongated protuberance which forms the preceding organ, are found the organs of vanity, which, fully developed, give to the head great amplitude behind.

10. Circumspection, foresight. Grave and reflective character. Disposition to calculate the chances of events. Inquietude. Fear. Irresolution.

This organ, like all those which are situated on the outside of the median line, presents two elevations, one on each side of the head, about the middle of the parietal regions, and forms above, behind that of cunning, a large protuberance.

11. Sense of things. Memory of facts. Educatibility. Perfectibility. Curiosity. Docility. (Disposition to perfect the action of the organs.)

This organ is formed of a prominence, which, commencing at the root of the nose, extends towards the middle of the forehead, and enlarges on each side of the median line, between the eyebrows.

12. Sense of localities, or of the relations of space. Desire of travelling. Cosmopolism. Memory of places. (Arrangement of things.)

The seat of this disposition is situated a little above the superciliary arches or eyebrows, more or less approaching the median line, or occupying the side of the forehead.

13. Memory of persons. Faculty of recognizing readily and of retaining remembrance. (Sense of forms. Configuration.)

Eyes, of whatever form, having the internal angle a little depressed, are the external sign which announces this faculty.

14. Sense of words. Verbal memory. Wonderful facility of retaining names and signs. Propensity to talk. Loquacity. (Talkativeness. Verbosity.)

Large and prominent eyes, having the external commissure thrown a little backwards, are the index of the present faculty.

15. Sense of language. Talent of philology. Aptitude to comprehend languages. Faculty of acquiring many languages. (Polyglotism.)

When the eyes are at the same time large, even with the head, and depressed below, they are the sign of a particular aptitude for the study of languages.

16. Sense of the harmony of colors. Talent for painting. Coloring, or sense of colors. Aptitude to seize their shades.

The organ of this talent is placed in the part of the forehead which is above, and exactly corresponds to the middle of the eye. Then the external part of the eyebrow is generally very prominent.

17. Sense of the relations of sounds and tones. Talent of music. Melody. Harmony. Aptitude to comprehend the accordance of musical sounds.

This organ is situated immediately above the external angle of the eye, and when it is much developed produces to a certain degree a square and swelling lateral part of the head.

18. Sense of the properties and relations of numbers. Algorithm. Mathematical talent. Faculty of calculation.

According to M. Gall, all mathematicians of note have the external half of the orbital arch in a right line, and the angle of the eye frequently projecting at the anterior part of the temples.

19. Measurement of time. Sense of mechanics or of construction. Talent which leads to perfection in the arts. (Dexterity.)

The external appearance of this organ is a rounded protuberance situated in the temporal region, sometimes behind the eye, sometimes a little higher, according to the developement of the neighboring organs.

20. Comparative sagacity. Faculty of discovering analogies and resemblances. Perspicacity. (Popular eloquence.) (Allegory.) (Apologue.)

A protuberance, which commences at the superior part of the forehead, and which descends, contracting itself in the form of an inverted cone, announces this faculty.

21. Metaphysical faculty. Depth of mind. Metaphysical penetration. (Faculty of abstraction and generalization.) Idiology.

This organ is formed of two prominences placed on the same horizontal line, one on each side of the preceding organ, of which they sometimes appear to be only a continuation.

22. Faculty of satire and repartee. Bel-esprit. Malicious spirit. Piquant disposition. Wit.

This disposition is indicated by a double prominence, or, as this must be always understood, by two circumvolutions, placed one on each side and behind those of the metaphysical faculty, and nearly on the same line.

23. Causality. Spirit of observation and induction, which refers effects to their causes. Reason of things. Philosophical head.

This faculty appears to be less the result of a special organ, than that of the conjoined developement of the whole anterior and superior part of the forehead. We may say it is a collective organ, which results from a happy assemblage of the superior faculties.

24. Organ of poetry. Poetic enthusiasm. Faculty of painting the thoughts in bright and glowing colors.

These dispositions belong to a protuberance situated at the summit of the head, on the median line, and behind the organ of theosophy.

25. Moral sense. Goodness. Mildness. Benevolence. Compassion. Sensibility. Conscience. Sentiment of just and unjust.

The organ of this faculty, perhaps one of the most imperious, is placed in the superior and lateral part of the head, a little above the temples.

26. Mimicry, or disposition to imitate the gestures, voice, manner, and actions of others.

These dispositions are owing to a developement of the circumvolutions placed upon the median line, at the anterior and superior part of the frontal bone, above the commencement of the hair.

27. Organ which disposes to visions. Love of the marvellous and supernatural. Illusion. Sorcery.

A prominence sometimes rounded, sometimes elongated, and situated a little behind and on one side of the organ of benevolence, is the external index of this disposition.

28. God and religion. Religious sentiment. Organ of theosophy or religious ideas. Veneration.

A circumlocution of the brain, situated between those which constitute the poetic faculty, and those which dispose to mimicry, appears to be the cause of this propensity.

29. Firmness. Constancy. Perseverance. Obstinacy. Disobedience. Mutiny. Seditious spirit. Independence of disposition.

A prominence placed on the median line, and which extends from the middle part of the front to the summit of the head, is the organic and innate source from which flows all creeds.

(To be continued.)

Months.—This division of the year appears to have been used before the flood;* and as it is naturally framed by the revolutions of the moon, the months of all nations were originally *lunar*, that is, from one new moon to another. In a more enlightened period, the revolutions of the moon were compared with those of the sun, and the limits of the months, as the component parts of a year, were fixed with greater precision. The Romans divided each month into *Calends*, *Nones*, and *Ides*; the *Calends* were the first day of the month, the *Nones* were the seventh, and the *Ides* the fifteenth of March, May, July, and October; in the other months the *Nones* fell on the fifth, and the *Ides* on the thirteenth. The days of each month, according to this form, were counted backwards; thus, the 18th of October was called *the 15th day before the Calends of November, &c.*. In the year 1793, the French Government had a new calendar constructed, in which they adopted the following fanciful designations for each month:

	French.	*Signification.*	*English.*
Autumn—			
	1. Vindemaire,	Vintage month, -	from Sept. 22
	2. Brumaire,	Foggy month, - -	Oct. 22
	3. Frimaire,	Frosty or sleety month,	Nov. 21
Winter—			
	4. Nivose,	Snowy month, - -	Dec. 21
	5. Pluvoise,	Rainy month, - -	Jan. 20
	6. Ventose,	Windy month, - -	Feb. 19
Spring—			
	7. Germinal,	Springing or budding mo.	Mar. 21
	8. Floreal,	Flowering month, -	April 20
	9. Prairial,	Hay harvest month, -	May 20
Summer—			
	10. Messidor,	Corn harvest month, -	June 19
	11. Thermidor,	Heat month, - -	July 19
	12. Fructidor,	Fruit month, - -	Aug. 19

This *new* calendar, which, after all, was only a plagiarism, or copy of one used in Holland from time immemorial, like many of the absurd institutions which sprang from the French Revolution, was laid aside in a few years, from the circumstance of its utter unfitness for the seasons, even as they occur in the several provinces of France itself; how much less applicable, therefore, must they have been to other countries, where the climates and seasons vary so much from each other! A calendar, to be worthy of universal adoption, must be capable of universal application. Not so that of the French *Philosophers*, which, independently of its discordance with those of all civilized nations, had not even the merit of indicating those very seasons from which it professed to derive its character. The late Mr. Grifford ridiculed this new-fangled method of registering time by the following ludicrous but happy translation of the republican months and seasons:

Autumn . . Wheezy, sneezy, freezy;
Winter . . Slippy, drippy, nippy;
Spring . . . Showery, flowery, bowery;
Summer . . Hoppy, croppy, poppy.

The Possibility of naturalizing the Fire-Fly.—It abounds not only in Canada, where the winters are so severe, but in the villages of the Vaudois, in Piedmont. These are a poor people, much attached to the English, and at ten shillings per dozen would no doubt deliver in Paris, in boxes properly contrived, any number of these creatures in every stage of their existence, and even in the egg, should that be desired; and if twenty dozen were turned out in different parts of England, there cannot remain a doubt, but that in a few years they would be common through the country, and in our summer evenings be exquisitely beautiful.—[Mag. Nat. Hist.]

* Noah, as we find it recorded in the Bible, reckoned by months of thirty days each; and from him that mode of computing the year is supposed to have been adopted by the Chaldeans, Egyptians, and other Oriental nations.

A Compendium of Civil Architecture, arranged in Questions and Answers, with Notes, embracing History, the Classics, and the Early Arts, &c. By Robert Brindley, Architect, Surveyor, and Engineer. [Continued from page 269.]

TUSCAN.

Q. Whence the origin of the Tuscan order?

A. It is ascribed to the people of Etruria, in Italy, immediately precursory to the Roman dawn of architecture, and claims its priority amongst the orders only by its simplicity and solidity. It bears decided marks of analogy to the Roman Doric; but is composed of few parts, nearly destitute of ornament, extremely massive, and now only used for vaulting, giving place to the Doric.

Q. What are the proportions of the pedestal?

A. It is a plain square block, in height two modules, and projects half the height of the plinth of the base beyond its face.

Q. Describe the column?

A. Including the base and capital, it is seven diameters or fourteen modules high; one of which is allowed for the capital. The upper part of the column is diminished two thirds of its height, making the diameter, under the neck of the capital, from one sixth to one fourth less than the base. This diminution is bounded by a curved line variously determined; but does not differ much from what an even spring would assume, if one part of it were bound in the direction of the axis of the shaft, to the cylindrical third, and then, by pressure at the top, only brought to the diminishing point. The shaft is never fluted.

Q. What of the base of the column?

A. It is one module high,—consisting of *plinth*, half a module; *torus*, quite plain, three eighths; *fillet*, or cincture, one eighth. The *apophyge*, parts of the shaft, as also all astragals under the capitals, in all rich orders, in masonry, should be executed on the shaft stones.

Q. Of what proportion is the capital?

A. It is one module in height, and consists of a *collarin neck* or *gorge*, sometimes called the frieze of the capital, in height one third of a module; the fillet or *cinture* one sixth of the gorge, above the apophyge; the ovolo one third of a module; and *abacus*, with a fillet, one third of a module.

Q. What is the projection of the capital?

A. Its greatest diameter across the abacus is two modules, and consequently projects one quarter of a module beyond the top of the shaft, being one half of a module less than the bottom. The ovolo projects one third of a module, and the abacus with a fillet, rather more.

Q. Describe the entablature?

A. It is quite plain, having neither mutules nor modillions; in height, three modules, consisting of architrave, three quarters of a module; frieze, one module; cavetto, one third; gaceiolatrio, one third; corona, one third; cima, one half. Sometimes the architrave has two faces.

Q. What is the projection of the entablature?

A. The architrave and frieze are exactly perpendicular to the bottom of the shaft; from the perpendicular line of which shaft, the cima projects one half of a module. The other parts gradually project more and more, being enumerated from the frieze upwards.

Q. What artist claims the honor of the Tuscan order?

A. Palladio. Some other Italian architects have varied in parts, and some have given a sort of block modillions, like those used in Covent Garden church; but these are wood, and ought not to be imitated in stone.

DORIC.

Q. To whom is the Doric order ascribed?

A. To the Dorians in general; but according to Vitruvius its origin is ascribed to Dorus, who built a temple to Juno, in the ancient city of Argos.

Q. What is the characteristic of this order?

A. It is of peculiar nobility, simple and bold, and called the *Herculean*.

Q. Did not the Romans considerably alter this order?

A. Yes; and by the regulations they introduced rendered it extremely difficult to be executed on large buildings. Hence two Doric orders are handed down to us.

GRECIAN DORIC.

Q. What are the proportions of the column?

A. In height, the column is eight diameters, or sixteen modules; the best example is six diameters, and is placed on the floor, without a pedestal or base, because men were in the habit of walking bare-foot. The roots of trees naturally suggested fluting.

Q. What is the proportion of the capital, and of what description?

A. The capital, which is one module in height, had no astragal, but a few plain fillets, with a channel between them, under the ovolo, and sometimes a small channel under the fillets. The ovolo is flat, with a quirk or return; on this was laid the abacus,

a plain tile, extending one third of a module beyond the perpendicular of the top of the shaft; the diameter of which is one fourth less than at the bottom.

Q. How is the entablature described?

A. The architrave and frieze are each more than a third in height, and the cornice less; the whole being two diameters high. The architrave has only a plain broad fillet; under which are placed the drops or guttæ, appearing to hang from the triglyphs.

Q. What is the disposition of the triglyph?

A. It is placed at the angle, bringing the interior edge over the centre of the column; and is an ornament peculiar to the style, having two triangular flutes forming a space between the grooves, equal to one module.

Q. Where is the metope?

A. Between the triglyphs, being the square of the height of the frieze; and a mutule was not only placed over each triglyph, but also over each metope; and it appears probable that the triglyphs were frequently omitted, except over the centre of each column. Hence the order would be easily worked at any desirable inter-columniation.

Q. What are the component parts of the cornice?

A. The cornice of this order consisted of a plain face under the mutules, which was measured as part of the frieze, and then the mutule, which projected, sloping forward under the corona, so that the bottom of the mutule was considerably lower in front than in the back. Over the corona was a small ovolo and fillet, and then a large ovolo and fillet for the cymatium.

Q. What are the ornaments of this order?

A. The flutings of the column, common to the order, are twenty in number, shallow, and not with fillets between them, but sharp edges. The flutes are much less than a semi-circle, and should be elliptic. At the corner, in the space formed in the soffit of the corona, by the interval of the two angular mutules, was sometimes placed a flower, and the cymatium of the cornice had lions' heads, which were real spouts. In addition to the guttæ, or drops under the triglyphs, the mutules have several rows of drops of the same shape and size.

Q. What is the projection of the entablature?

A. Generally one third of the diameter of the bottom of the pillar; sometimes, however, exceeding this.

ROMAN DORIC.

Q. What is the distinction in the Roman Doric?

A. First, the triglyphs must be precisely over the centre of the columns; 2d, the metopes must be exact squares; 3d, the mutules square, rendering the inter-columniation, in large buildings, to accommodate the internal arrangements, extremely difficult.

Q. What other distinction?

A. It is sometimes set on the attic base, which is one module and a third high; dado, two modules and a half; ovolo and fillets, half a module; base projects three quarters of a module; and ovolo, one module from the perpendicular of the column.*

Q. What are the mouldings employed in the pillar?

A. The plinth, in height, one third of a module; lower torus, one quarter of a module; cavetto, and upper and lower fillets, one sixth of a module; the upper torus, one sixth; cimbia, one minute and a half; astragal, four minutes.

Q. What is the proportion of the shaft?

A. The shaft, including the base and capital, each of which is half a diameter, is eight diameters, or sixteen modules high, and fluted like the Grecian.

Q. Describe the capital?

A. The capital, one module, has an astragal, collarin gorge, or neck, one third of a module, three fillets, three minutes; ovolo, one quarter of a module; abacus, one quarter of a module; cima recta, one sixth of a module.

Q. What is the projection of the capital?

A. The cima recta projects one third of a module beyond the perpendicular of the top of the shaft; the diameter of which is one quarter less than at the bottom.

Q. What of the entablature?

A. The architrave is only two thirds of the frieze, equal in height to the cornice. The architrave has sometimes two faces; frieze, nothing peculiar in this mode; cornice flat; mutules square, with square intervals; guttæ often omitted; cymatium, a cavetto, with ogee under; sometimes a cima recta; mutules have a small ogee running round them and the face of which they are formed; flat fillet, running round the top of the triglyph, belongs to the cornice; dentils sometimes used.

Q. What of the ornaments?

A. The order is susceptible of many, in addition to flutes, &c.: neck of capital has sometimes eight flowers or husks round it, the ovolo carved, and the metopes in the frieze filled with alternate ox-sculls and pateræ. In the interior, sometimes, the mouldings of the cornice are enriched.

---

* This base is sometimes used in the Grecian Doric by the moderns.

GRECIAN AND ROMAN IONIC.

Q. To whom is this order ascribed?

A. It is ascribed by Vitruvius to Ion, who built a temple to Apollo, in Asia, and fixed the proportions of this most delicate order, sometimes called the feminine or female order, on account of its light and elegant appearance; the volutes, with the festoons, resembling locks of hair decorated with flowers.

Q. What is the distinction between the Grecian and Roman Ionic?

A. In Greece the volutes were placed flat in the front and back of the column, leaving the two sides of a different character, and forming a balustre. An angular volute was sometimes placed there, showing two volutes to each exterior face, and a balustre to each interior. The list or spiral line of the volute runs along the face of the abacus, straight under the ogee. In Rome a capital was invented with four angular volutes, and the abacus with its sides hollowed out. The list springs from behind the ovolo, and in the hollow of the abacus, which is an ovolo, fillet, and cavetto, is placed a flower.

Q. What are the proportions of the capital?

A. The height of the volute is seven minutes; ovolo, eight minutes; abacus, five minutes; projection of outermost circle of the volute exactly perpendicular to the line of the bottom of the shaft.

Q. Of what description is the pedestal?

A. It consists of plinth, half module high; base of pedestal, one quarter module; dado, one module and a half; cima reversa, one third module; projection of plinth and cima reversa, one third module.

Q. Of what proportion is the shaft?

A. Including the base (which is a half diameter, or thirty minutes,) and the capital, to the bottom of the volute, a little more, is nine diameters or nine modules high. It has several bases. Some of the Grecian examples are of one torus, two scotiæ, with astragal and fillet; others of two large tori and a scotia of small projection; but the attic base is often used, with an astragal added above the upper torus, making a beautiful base. The shaft may be fluted in twenty-four flutes, with fillets between them; these flutes are semi-circular.

Q. What are the entablatures of this order?

A. Three: 1st, plain Grecian; architrave often of one face; frieze plain; the cornice composed of a corona, with a deep soffit; bed-mould moulding hidden by the drip of the soffit, or coming very little below it, and sometimes with a plain dentil set close under the corona, the cymatium, a cima recta, and ogee under it. The whole height of entablature is one module and three quarters; architrave and frieze each forty minutes. 2d, mostly used with the Grecian capital at Rome, has generally two faces in the architrave; and the cornice, which is rather more than one third of the entablature, has the corona, with a cima recta, and ogee, for cymatium; and for bed-mould, a dentil face between an ovolo and ogee; the soffit of the corona sometimes ornamented; height of entablature one module and three quarters; architrave, twenty-eight minutes; frieze, thirty-eight minutes; corona, forty minutes. 3d, *modillion entablature*—same architrave, frieze, and cymatium of its cornice as last, under the soffit of the corona are plain modillions, surrounded by a small ogee, one placed over the centre of each column, and placed close to the return, making a square panel on the soffit; in the corner, between each modillion, there is often a flower—bed-mould below an ovolo, fillet, and cavetto.

Q. What projection is the cornice?

A. Half a module beyond the perpendicular line of the bottom of the column.

NOTE.—It was once the custom to work the Ionic frieze projecting like a torus, which impropriety has been driven out by improved Grecian models. This order can be ornamented by carvings.

CORINTHIAN.

Q. From whence has the Corinthian order arisen?

A. It had its name and origin from Corinth; and the many remains of antiquity show the prevalence of this order amongst the ancients; though the Romans annihilated every vestige of it in the destruction of their great and rival city, by L. Mummius, A. C. 146.

Q. What is the character of this order?

A. The general character is lightness and extreme elegance; in which qualities it is superior to the Ionic. The latter resembles a matron, and the former a virgin.

Q. What is the great mark of distinction in this order?

A. The capital, having arisen out of the two former orders; and is said to have been further suggested by observing a tile placed on a basket left in a garden, and round which sprang up an acanthus.*

Q. What are the component parts of the pedestals of the column?

A. They are the same as the Doric and Ionic, but more elegant, and ornamented.

* All the other orders have in different countries and situations much variety; but the Corinthian, not without slight variations, even in the antique, is much more settled in its proportions; and its greater or less enrichment is the principal order of variety.

The pedestal, in height, should be one fourth of the column.

Q. Of what proportion is the column?

A. Including the base, of half a diameter, consisting of several annulets and fillets, and the capital, one diameter, it is twenty modules or ten diameters high.

Q. Describe the capital?

A. The height is rather more than the diameter, consisting of an astragal, fillet, and apophyge, all measured with the shaft; then a bell and horned abacus. The bell is set round with two rows of leaves, eight in each row; and a third row of leaves supports eight small open volutes, four of which are under the four horns of the abacus, and the other four, often interwoven, are under the central recessed part of the abacus, and have over them a flower or other ornament; the volutes spring out of small twisted husks placed between the leaves of the second row, called *caulicoles*. The abacus consists of an ovolo, fillet, and cavetto, like the modern Ionic. There are several modes of indenting the leaves, called, from these variations, acanthus, olive, &c.

Q. What of the entablature of this order?

A. It is very fine, being one fifth of the column in height, resembling the Ionic. The architrave has mostly two or three faces, with small ogees or beads between them, being thirty-five minutes in height. The frieze is flat, often joined to the upper fillet of the architrave by an apophyge, thirty-five minutes. The cornice, forty minutes high, has modillions and dentils, thus composed: above the corona is a cymatium and small ogee; under it, the modillions, whose disposition, like the Ionic, must be over the centre of the column, and one close to the return of the cornice; these modillions are carved with a small balustre front, and a leaf under them, surrounded at the upper part by a small ogee and fillet running round the face from which they spring. Under the modillions is placed an ovolo, then a fillet and a dental face, often left uncut in exterior work; under the dentils are a fillet and ogee.

Q. What is the projection of the cornice?

A. Like the Ionic, it projects half a module beyond the perpendicular line of the bottom of the column.

Q. What are the enrichments of this order?

A. They may be very considerable: mouldings of pedestal enriched; shaft fluted, like Ionic, in twenty-four flutes, filled one third high by staves, called *cabling* the flutes; mouldings of architrave and even faces; mouldings of corona; squares of soffit of corona panelled and flower; frieze adorned with carvings. A redundancy of ornament for exteriors, however, is an evil.

COMPOSITE.

Q. Whence the origin of this order?

A. It was composed from the Corinthian and Doric orders, by the Romans—hence called the Roman Composite.

Q. What is the distinguishing feature?

A. The capital—having a bolder appearance than the Corinthian.

Q. What of the pedestal?

A. The same as the Corinthian in proportions.

Q. What of the column?

A. It is twenty modules or ten diameters high; fluted and based like the Corinthian.

Q. What height is the capital?

A. One diameter, and formed by setting, on the two lower rows of leaves of the Corinthian capital, the modern Ionic volutes, ovolo, and abacus. The small space left by the bell is filled by caulicoles, with flowers; and the upper list of the volute is often flowered.

Q. Describe the entablature?

A. It has only two faces to the architrave; upper mouldings bolder than the Corinthian. The cornice is different, having a sort of double modillion, consisting of two faces, the upper projecting farthest, and separated from the lower by a small ogee. Under the modillion is commonly a large ogee, astragal, and fillet. A plain cornice is sometimes used to this; and also a cornice with the modillions bolder, and cantilivers under them in a frieze. In height the cornice bears the same proportion as that of the Corinthian.

ORDERS OF SACRED TEMPLES OF THE GREEKS.

Q. What were the orders of the sacred temples of the Greeks?

A. They were seven, namely, Antis, Prostyle, Amphiprostyle, Peripteral, Dipteral, Pseudo-dipteral, and Hypæthral.

Q. What is the order of Antis?

A. The Antis is that wherein the ends of the flank walls finish in pilasters, or antæ, and have two columns between them, such as Inigo Jones' fine Tuscan portico of St. Paul's church, Covent Garden.

Q. Describe the Prostyle?

A. This differs from the Antis, by having columns added opposite the pilasters, or antæ of each corner, with others intermediate. The foregoing orders have only porticos at one end.

Q. What is the Amphiprostyle?

A. The same as the Prostyle, but, as its name imports, with a posticum, or rear front, the same as the principal front.

Q. What is the Peripteral?

A. This order has also porticos at both ends of six columns, and eleven, counting the angle columns on each side. It had, as signified, columns all round about the cell, as in the temple of Theseus, which has two more columns in flank than the rules of Vitruvius prescribe.

Q. What of the Dipteral?

A. This order, which Vitruvius places after the Pseudo-dipteral, is Octastyle, or eight columned, like the Portico of the Parthenon, but has a double row of columns round the cell.

Q. What of the Pseudo-dipteral, or false Dipteral?

A. The porticos are Octastyle, or eight columned in front, and on each side fifteen, counting those of the angles. The Parthenon is of this order of temples, but has seventeen columns on the sides—the Greeks not confining themselves to every rule of the critic, yet never losing the true spirit of the original.

Q. Describe the Hypæthral order of temples?

A. This order is Decastyle, or ten columned, both in front and rear; the other parts are distributed the same as the Dipteral, but it has in its *interior* a double row of columns, one higher than the other, continued on all sides, and resembling an interior porch, and is called, from its situation, a Peristyle. The middle part has no roof. A fine example of this order of temples is to be found in that of Jupiter Olympus, at Athens. In Rome there is no example of it.

Q. What is the description of the *circular* temples?

A. They do not class under any of these orders. Some of these temples are denominated *Monopteral*, having one row of columns round about them, and no cella. Others are called *Peripteral*, having a cell round which the columns are arranged, standing on a continued pedestal, designated a *Stylobate*, like the temple of the Sybils, at Tivoli, the choragic monument of Lysocrates at Athens, and the temple of Vesta at Rome.

INTERCOLUMNIATION OF ORDERS.

Q. What is to be comprehended by the intercolumniation of orders?

A. It signifies the manner of distributing the columns according to regulations formed on good taste, reason, beauty, and strength.

Q. How are the columns disposed?

A. They are either insulated or engaged.

Q. What are insulated columns?

A. Columns detached from the wall, either very near or at a considerable distance from it.

Q. When at a distance from the wall, for what purpose are they?

A. To support an entablature; and the distance from each other should be consistent both with their real and apparent solidity.

Q. What are engaged columns?

A. Columns attached to the wall, and are not limited in their intercolumniations, as they depend on the breadth of the arches, doors, windows, niches, or other decorations placed between them.

Q. What different species of intercolumniation did the ancients use?

A. According to Vitruvius and Palladio they are as follows: 1st, the *Pycnostyle*, of which the interval or space is one and a half inferior diameter of the columns—of this style are the Parthenon, and temple of Theseus; 2d, the *Systyle*, whose interval is two diameters; 3d, *Eustyle*, two diameters and a quarter; 4th, *Diastyle*, three diameters; 5th, *Aræostyle*, four diameters. The first three of these were used by the Grecians, in the Doric, Ionic, and Corinthian orders; but the distance of the triglyphs of the Doric determine the intercolumniations of that order.

Q. Which intercolumniation had the preference amongst the ancient Romans?

A. The Eustyle in most cases, as the best medium of the too little and too great intervals of the column; but in their Tuscan works they used a space equal to four, and sometimes six, diameters, which intercolumniation was admissible in this order, since the architrave was usually formed of some kind of timber when the other parts of the entablature were of stone.

Q. What observation has Palladio made on this subject?

A. That "this intercolumniation was adopted to farm-houses and other rustic work, as it afforded a passage for carts, and was least expensive. In structures, however, built entirely of stone, they used a shorter interval, more suitable to the length of their blocks of marble." Hence the diastyle and eustyle modes were sometimes applied to this order. This style appears to be adopted to every order by the moderns, excepting the Doric.

Q. What modern contrivance is sometimes adopted as regards the aræostyle, authorized by a few examples of the ancients introduced into porticos and peristyles?

A. A mode adopted by Perrault, and is managed by placing two columns together, at the angles, so close as to admit the two capitals nearly into contact; the intermediate columns are similarly placed. This man-

ner, which is termed *grouping*, takes off from the excessive width of this kind of interval, whilst it adds to it both real and apparent strength. Examples are found in St. Paul's Cathedral, and St. James' Park, London, and in the Palace of the Loire, at Paris.

Q. What of the intercolumniation of the Doric order?

A. It is often attended with peculiar difficulty, arising from the strict regard that is ever paid to the true width of the triglyph, and the perfectly square form of the metopes or their intervals. In some instances, the mutules and triglyphs have been omitted in capital works, both ancient and modern, as in the Colosseum, at Rome, and the Royal Hospital, Greenwich.

Q. How is the intercolumniation of the Doric effected, when the capitals and bases have their proper projections, and are at any distance from each other?

A. The metope between them will be rather too wide; but that may be obviated by confining the projections, or making the triglyph one minute more than it really should be, and placing or removing its centre one minute within the axis of the column, which trifling distance will not be perceived without the nicest examination.

TRIUMPHAL ARCHES.

Q. What is to be advanced upon the subject of triumphal arches?

A. They were much used among the ancients, with various decorative ornaments: some had their piers rusticated, others adorned with pilasters, termini, or caryatides, and sometimes they were made sufficiently broad to admit of niches or windows.

Q. Of what description was the circular part of the arches?

A. They were either surrounded with rustic key-stones, or with an archivolt enriched with mouldings, which in the middle is sometimes interrupted by a *console*, or mask, serving at the same time as a key to the arch.

Q. How is the archivolt supported?

A. By an impost at the head of the pier, and at others by columns placed on each side of it with a regular entablature or architrave and cornice.

Q. From whence does the circular part of arches of great magnitude spring?

A. Not immediately from the impost, but takes its rise at such a distance above as is necessary in order to have the whole curve seen at a proper point of view.

Q. What is the proportion of the void or aperture of arches?

A. It should never be higher nor much lower than double their breadth.

Q. What is the size of the pier?

A. The breadth of the pier should not exceed two thirds, nor be less than one third, of the breadth of the arch; and the angular pier ought to be broader than the others by one half, one third, or one fourth.

Q. Of what thickness should the pier be?

A. This depends on the breadth of the portico. It must be strong enough to resist the pressure of the vault.

Q. Of what proportion should the impost be?

A. Not more than one seventh, or less than one ninth, of the aperture.

Q. What of the archivolt and console?

A. The archivolt is from one eighth to one tenth of the aperture. The breadth of the console must, at the bottom, be equal to that of the archivolt, and its sides drawn from the centre of the arch; the length of it should not be less than one and a half of its smallest breadth, nor more than double the same.

Q. What are the proportions of the Tuscan arch without pedestals?

A. In height the aperture is seven diameters and a quarter; in width, four diameters; and from centre to centre of the columns, six diameters; plinth, one diameter in height; columns, agreeably to order.

Q. What are the proportions of this order with pedestals?

A. In width, four diameters and a half; in height, eight diameters and a quarter; from centre to centre of each pedestal, six diameters and three quarters.

Q. What are the proportions of the Doric order without pedestals?

A. In height, seven diameters and three quarters; in width, four diameters and fifteen minutes; piers, two modules in front; in thickness, one module, twenty-two minutes and a half, or in proportion to their distance from the wall; from centre to centre of each pier, six diameters and fifteen minutes.

Q. What are the proportionate arches of this order with pedestals?

A. Their apertures in height are nine diameters, thirty minutes; in width, five diameters, fifteen minutes; pier, two diameters, fifteen minutes wide; in front, and from centre to centre of each, seven diameters, fifteen minutes.

Q. Of what dimensions are the arches of the other orders?

A. They bear analogy to these last mentioned, differing but little in proportion, and only discovered by the character of the ornaments; beautiful specimens of which are to

be met with at the entrance of the metropolis and the king's palace.

Ancient Marks on Paper.—Every one knows how often we are obliged to refer to ancient times to explain common terms of art, and words which are in every one's mouth. We have a curious instance of this in the names which are given to the different sorts and sizes of paper. We all talk of *foolscap-paper*, *post-paper*, and *note-paper*; and paper-makers and stationers have other terms of the same kind, as *hand-paper*, *pot-paper*, &c. Now, the term note-paper is clear enough, as it evidently means paper of the size fit for notes; while *post-paper*, we may suppose, means the larger size, which is used for letters sent by the post. But when we come to *foolscap* paper, we are altogether at a loss for an explanation; and here we find we must look to something else than the size of the paper as to the origin of the name. Now, if we go back to the early history of paper-making, we find that terms which now puzzle us so much may easily be explained by the various paper *marks* which have been used at different times. In ancient times, we know, when very few people could read, pictures of every kind were very much in use where writing would now be employed; every shop had a sign, as well as every public house; and these signs were not then, as they very often are now, only printed on a board; they were always either painted pictures, as many inn signs still are, or else models of the thing which the sign expressed, as we still sometimes see a bee-hive, a tea-canister, or a doll. For the same reason, printers had always some device which they put upon the title pages, and at the end of their books; and paper-makers used marks to distinguish the paper of their manufacture from that of others. Some of these marks becoming common, naturally gave their name to different sorts of paper; and as names, we all know, remain very long after the origin of them is forgotten, and the circumstances changed, we shall not be surprised to find the old names still in use, though perhaps in some cases they are not applied to the same things they originally denoted. It will be the best way, perhaps, to mention briefly the chief paper marks which have been used, as they occur in the order of time. The first paper-maker in England is supposed to have been John Tate, who is said to have had a mill at Hertford; his device was a star of five points within a double circle. The first book printed on paper manufactured in England was a Latin one, entitled *Bartholomeus de Propriētatibus Rerum.* It was printed in 1495 or 1496. The paper seems to have been made by John Tate, the younger, and had the mark of a wheel. The paper used by Caxton, and other early printers, had a great variety of marks, of which the chief are the ox-head and star, the letter P, the shears, the hand and star, a collared dog's head, with a trefoil over it, a crown, a shield, with something like a bend upon it, &c. The ox-head, sometimes with a star or flower over it, is the mark of the paper on which Faust printed some of his early books; but the open hand, which was likewise a very ancient mark, remained longer in fashion, and probably gave the name to what is still called *hand-paper*. Another very favorite paper mark, at a somewhat later period, was the jug or pot, which seems to have been the origin of the term *pot-paper*. It is sometimes found plain, but oftener bears the initials or first letters of the maker's name; hence there is a very great variety of figures, every paper maker-having a somewhat different mark. The hand and pot marks existed from 1539 to 1639, as may be seen in old Bibles. The foolscap was a later device, and does not seem to have been nearly of so long continuance as the former. It has given place to the figure of Britannia, or that of a lion rampant, supporting the cap of liberty on a pole; the name, however, has continued, and we still denominate paper of a particular size by the title of foolscap paper. The figures have the cap and bells which we so often read of in old plays and histories, as the particular dress of the fools, who formerly formed a part of every great man's establishment. Post-paper seems to have derived its name from the post-horn, which was at one time its distinguishing mark. This is of later date, and does not seem to have been used before the establishment of the General Post-Office, when it became the custom to blow a horn. This mark dates from 1670 to 1679. The mark is still sometimes used; but the same change which has so much diminished the number of painted signs in the streets of our towns and cities, has nearly made paper marks a matter of antiquarian curiosity, the maker's name being now generally used.—[Saturday Magazine, No. 11.]

Carriages.—Wheel carriages for pleasure are generally supposed to have first come into use in England in the reign of Queen Elizabeth. But long before that time carriages of some sort were used on state occasions, or for the convéyance of sick persons. Even in the time of the Saxons, a clumsy kind of car, on four wheels, was

employed to carry great personages; and Stow tells us, that, during Wat Tyler's insurrection in 1380, Richard the Second, "being threatened by the rebels of Kent, rode from the tower of London to the Miles End, and with him his mother, because he was sick and weak, in a *whirlicote*," which is supposed to have been a sort of covered carriage. "Chariots covered, with ladies therein," followed the litter in which Queen Catherine was carried to her coronation with Henry the Eighth. But Queen Elizabeth's is the first that was called a *coach*. In 1564 William Booner, a Dutchman, became the Queen's coachman, and about this time coaches were brought into general use in England. In 1588 Queen Elizabeth went from Somerset House to Paul Cross, to return thanks on the destruction of the Spanish Armada, in a coach presented to her by Henry, Earl of Arundel. These coaches must have been clumsy uncomfortable machines. They had no springs, and the state of the streets and roads must have made travelling in them any thing but easy. But fashion brought them into such general use, that in 1607 Dekker complains that "the wife of every citizen must be jolted now." And in 1636 there were 6000 of them kept in London and the neighborhood. At first they had only two horses, but afterwards the number was increased. In the reign of James the First, "the stout old Earl of Northumberland, when he was got loose, hearing that the great favorite Buckingham was drawn about with a coach and six horses, thought he might very well have eight in his coach, with which he rode through the city of London to the vulgar talk and admiration." In general, however, it was thought disgraceful in those times for the male sex to ride in coaches. "In Sir Philip Sydney's time, so famous for men at arms, it was then," says Aubrey, "held as great a disgrace for a young gentleman to be seen riding in the streets in a coach, as it would now for such a one to be seen in the streets with a petticoat and waistcoat, so much is the fashion of the times altered." Sir Walter Scott says, it is a tradition in Scotland, that chaises or chariots were first introduced into that country in 1745. Before that time the nobility were accustomed to travel in vehicles somewhat resembling Noah's ark, and the gentry on horseback; but in that memorable year, the Prince of Hesse appeared in a carriage of this description, "to the admiration of all Scotchmen, who regarded it as a coach cut in half." When we compare the clumsy things in which even our kings formerly rode, with the convenient and light carriages of the present day, we cannot help admiring the progress which our workmen have made in this and every other branch of art, and hoping that their skill may always find that encouragement which it so well deserves.—[From a paper in the Archæologia, by J. H. Markland, Esq.]

Popular Whims and Superstitions, relating more especially to the Practice of Medicine in the Nineteenth Century. By W. [From the Scientific Tracts and Family Lyceum.]

Some of the popular superstitions of the present day, respecting the practice of physic, may show the errors with which physicians have to contend. They may likewise show that information has not extended among the people at large to so great a degree as is generally believed. They may be curious relics for succeeding generations. They will teach that men of the present day, who are uneducated, have made but a small advance from the Goths and Vandals of ancient Europe, and from the Greeks and Romans, who prognosticated future events from the writhing entrails of dying birds and beats. Science, and that alone, will ultimately remove these errors; but, in the language of an elegant writer, "Before truth, in its silent and disputed march, has roused the attention of the indolent, converted the supercilious, subdued the interested and obstinate, and reached the ears of all, an age has passed away."

Whim 1st. It is a general belief that the green bark of elder, (*Sambucus canadensis*,) scraped up the stalk, and taken in decoction, will produce vomiting; scraped down, it will produce a cathartic operation. An intelligent physician, who heard the observation, humorously remarked, "Yes, and scraped round the stalk, it will pass directly out at the navel."

2d. Take a live black snake, and bite him through from his head to his tail, and the teeth will never afterwards ache or rot.

3d. Another. To prevent future attacks of the tooth-ache, extract a tooth, and bore a hole with an auger into the *north side* of a white oak tree, and place the tooth therein. Plug up the hole, and the remaining teeth will never ache until the plug decays.

4th. In colic, inflammation of the bowels or inflammatory rheumatism, skin a sheep or a cat *alive*, or open a hen alive, and apply her, or the warm skins of the animals, to the affected part, and they will immediately relieve and cure the disease.

Remark.—That warmth may be serviceable in these complaints is undoubtedly true

but the same benefit would unquestionably result from applying an emollient poultice.

5th. Steep the excrements of a sheep or lamb in cider, and give it to a patient in the measles, and it will effectually force out the eruption. This is known by the name of "nanny tea."

6th. To cure the epilepsy, or falling-sickness fits, procure the upper part of the skull of a dead man, pulverize and take it every day until the patient is cured.

7th. Wearing a red string or a string of gold beads round the neck will cure or prevent the nose-bleed. Wearing a tansy-bag on the stomach will cure worms.

8th. Throwing a woman's milk into the fire will dry it up in her breasts. Milk a cow upon the ground, and you will dry up her milk. If you kill a toad, it will cause your cow to give bloody milk.

9th. Innumerable are the whims and superstitions with regard to the cure of warts. Caustic and the knife will undoubtedly eradicate them. Sometimes they will go off of themselves.

Steal a piece of fresh meat and bury it; as the meat rots, the warts will disappear. Throw the meat into a neighbor's well, and the warts will recede, and your neighbor will have them.

10th. The membrane which frequently invests the head and body of a child at birth is called the veil; take this veil, wash it, and lay it into a drawer. If any of your family are absent, at whatever distance, whenever you examine this veil, if it is red, you may be sure that the absent person is well, but if it is pale, you may be sure that he is dead. If you examine it every day, you can tell the day he died.

11th. *Sayings upon child-birth.*

Monday, fair in the face;
Tuesday, full of grace;
Wednesday, sour and sad;
Thursday, merry and glad
Friday, loving and giving;
Saturday, work hard for a living;
Sunday, never to want.

12th. Nail a horse-shoe over the threshhold of your door, and it will drive off witches.

"The sacred horse-shoe, guardian of the whole,
Terror of sprites profane and witches foul,
Dread, powerful talisman, 'gainst imps unknown!
Nail'd on the door, in silent mystery shone."

This superstition is of ancient date, but it is much believed in by the ignorant at the present day.

13th. The belief in the divining rod is prevalent. The rod is of witch-hazel, (*Hamamelis virginica.*) Whenever the conjurer walks over the ground where the supposed mineral is, the rod will incline towards the mine.

14th. The moon, with many people, has a great influence upon the operations of husbandry, manufactures, and many diseases. It is believed that you cannot make good soap in the old of the moon; but if you make it in the new of the moon, and when the tide is coming in, you will uniformly be successful. So of killing hogs: if you butcher them in the new of the moon, or when it is nearly at its full, your pork will swell in the pot while boiling; but if you kill them at the old of the moon, or when it is in the wane, your pork will shrink in the pot. Particular attention must be paid to the state of the moon in pruning your trees, sowing grain, and other operations of husbandry. The moon, likewise, has great influence upon the weather.

15th. Nearly akin to the superstition with regard to the moon is the belief of certain signs respecting the singing of birds, upon the weather. The whistling of a quail, the singing of the robin and of the cuckoo, and the singing of tree-toads, are certain signs of the immediate approach of rain.

16th. You must not *commence* any work upon Friday, or engage in any new business; if you do, you will be sure of being disappointed.

17th. In case of amputated limbs, the belief is that the limb cut off feels every impression upon it—in the same manner that it did before it was amputated. If it is heated by the fire, the patient also feels heat; if it be struck, the patient likewise feels the blow.

18th. *Consumption.*—A superstition somewhat common among the most illiterate classes of the community is, that if the portions of the lungs which remain after a friend has died with the consumption, be taken out and burnt, the remainder of the family of the deceased will never afterwards be liable to the complaint. I have known the bodies of three or four people, who had died of consumption, disinterred, some of whom had been buried six or seven years, and their viscera burnt to ashes. What is remarkable, a physician attended as master of the ceremonies.

19th. But of all the superstitions with which we have to contend, that of resorting to patent secret medicines, and to patent steam-quacks, is the most common, the most humiliating, and the most degrading. Other superstitions debase the human mind; these sport with and destroy human life. In continental Europe the sale of secret remedies is prohibited by law, while in England and the United States it is made profitable to the government. "Ignorance and creduli-

ty," says Dr. Darwin, "have ever been companions, and have misled and enslaved mankind." W.

April 23, 1834.

PENNSYLVANIA COMMON SCHOOLS.—We rejoice that the great state of Pennsylvania has at length adopted a system for the management and direction of her common schools, and that its features are, in the main, so excellent. From the report acknowledged in our last number, from the Hon. Samuel Breck, to whom the state is indebted for preparing and carrying through the measure, and the amended act, since become a law by the signature of the Governor, we learn that the fund established in that state in 1831, for the aid of common schools, now amounts to $546,563, and will soon be $2,000,000. The new bill appropriates $75,000 of its revenue for the year 1835, and the same annually thereafter, until the fund yields $100,000, to be applied to those districts which comply with the conditions of the new act. This act makes each county in the state a school *division*, and every ward, township, and borough in each, a school district, which district shall contain a sufficient number of schools for the education of all within its limits who shall be offered. This new division of the state does not, however, interfere with the special regulations made by former acts for the city and county of Philadelphia.

The new statute requires that every district shall have six school directors, two of whom shall be elected annually. Their duty is to determine the number of schools which shall be necessary; to procure proper buildings; "to appoint capable teachers, at liberal salaries," and provide generally for the operation of the schools. They are to receive no compensation for their services, but an exemption from serving in the militia, or in township and borough offices. Two or more of the directors must visit the schools, at least once a month, and make an annual report to the *inspectors*.

The inspectors are two persons in each district, appointed annually by the courts of quarter sessions. Their business is to visit every school at least once in three months; to inquire into the moral character, learning, and ability of the teachers; examine candidates for teaching; and grant certificates, for one year only, to those who shall be found qualified. They may require teachers to be examined publicly. They must also investigate the condition of the schools, as to the progress of the pupils, and their discipline, the character of the teachers, the branches taught, &c., and report annually, to the superintendent; which report must be published. Their only compensation is the same as that of the directors.

The Secretary of the State is to be the Superintendent of the schools, whose duties, as defined by the statute, are nearly the same with those of the Superintendent of Common Schools in the state of New-York. He must also settle all controversies that may arise in regard to the duties of inspectors and directors, and in regard to school money.

In order to prevent the school fund from excusing individual exertion, and to make it operate as a stimulus, an annual joint meeting, of one delegate from each board of district directors in a county, together with the county commissioner, shall be held, who shall determine whether a tax is necessary to meet the school expenses. If they determine a tax to be necessary, it shall be levied; but no tax shall be less in amount than *double the sum furnished them from the revenue of the school fund*. But if they determine that no tax is necessary, the districts whose delegates voted in the negative shall not be entitled to any aid from the school fund for that year; but the money to which they would otherwise have been entitled shall be divided among those districts whose delegates voted in the affirmative. If no tax is voted, the old law shall be considered in force, without any regard to the school fund. If a tax is agreed upon, a public meeting of the citizens of each district shall be called, who may increase the tax, if they think it necessary. This last is one of the most valuable portions of the bill.

A majority of four in six of the directors may connect manual labor with study, in their several districts, and purchase the necessary materials, and employ persons to instruct the pupils in the mechanic arts and in agricultural pursuits, whenever they think it expedient.

The bill, as it came from the hands of the committee, made provision for the education of teachers,* but the amendments of the Senate excluded it. A less important section, which required the teachers in the several

* One *petition* was presented against the provision for the education of teachers. The following letter of a schoolmaster from the same county, which we copy *literatim* from the Philadelphia Gazette, may suggest the reason:

"I take the pen in Hand to Notice you That I wand that money Where your Son went to School to me last Winter to me Henry Krebs in ———— and I shall write you the bill of his Schooling Where he went is 42½ Cents and a half and the amount of the Rens 11 Cents and so the whole amount is 53½ cents and So I have no more to write at present Henry Krebs his hand and pen august the 15th 1833 &c

HENRY KREBS."

divisions to adopt, yearly, *a uniform course of study* to be pursued by *every school in the division*, shared the same fate.—[Annals of Education.]

Attempt to assign the Cause of the Spontaneous Combustion of Charcoal. By Mr. John Davies, Member of the Wernerian Society of Edinburgh, &c. and Lecturer on Chemistry, &c.

In the above interesting paper, no attempt has been made by the author of it to furnish an explanation of the phenomenon which he has established and described; and as every inquiring mind will direct its attention to a rationale of the operation, I presume that some remarks which have occurred to me within the few last days, and which may at least supply some aid in the discussion, may be without impropriety appended to the paper. These remarks, though theoretical, are countenanced by experimental analogies, which, if they fail to establish the accuracy of the speculation, may, at least, excuse its introduction.

A statement of the mode in which the charcoal in question is made, will be necessary in the subsequent explanation. Small fragments of wood, generally stripped of their bark, are put into iron cylinders, and exposed to intense heat, in order to effect the distillation of the volatile constituents for the manufacture of iron liquor. Now, Mr. Brunner resorted to a similar procedure in obtaining potassium from potash and charcoal; and as we know that potash may be procured from the wood employed by Mr. Hadfield, we have in his manufacture the same operation and the same materials as in M. Brunner's experiment, and may therefore expect the same results. The only difference would be, that as M. Brunner used much potash, he procured a large proportion of the metallic base; while in the other case the potassium must be in small quantity, because all the potash present would be only that supplied by the wood subjected to distillation: and yet, upon the whole, the quantity extracted under the latter circumstances is not inconsiderable; for it is by the combustion of such wood in America, where it is of comparatively little value, that the potash is principally formed which is consumed in the arts and manufactures in every part of Europe.

It is manifest, therefore, that in the formation of Mr. Hadfield's charcoal, potassium must, in small quantities, be liberated.

Supposing the presence of potassium in fresh charcoal to have been established, we have now to explain its operation; and this appears to be effected upon the assumption that the metal lingers in the pores of the charcoal, incased, as it were, in the substance, until it be at length exposed to the action of atmospheric air and aqueous vapor. This view of the subject derives plausibility from the facts, that the combustion does not commence at any considerable depth below the surface; and that when a thermometer is introduced into the mass, the ignition generally originates in that place; that is to say, the combustion occurs exactly where it might be expected, since it takes place at the part which, favorably situated, is most exposed to the action of the supporter of combustion.

This general view of the spontaneous combustion is directly countenanced by the excellent paper of Colonel Aubert, inserted in the "Bulletin des Sciences Militaires" for January, which Mr. Hadfield has offered me the opportunity of consulting. This ingenious foreigner shows by a number of decisive experiments, that the absorption of air and moisture is indispensable in the production of the phenomenon. He proves also, (what Mr. Hadfield has in a different way very clearly confirmed,) that no carbonic acid is formed before the incandescence occurs—a fact strictly in accordance with the hypothesis which I have offered; since upon this hypothesis the oxygen of the air, instead of forming an acid with the carbon, produces, by its superior affinity, an alkali with the potassium. The next position which he establishes, is that the carbon increased in weight in proportion to the quantity of air and moisture absorbed; and this should, according to the explanation suggested, occur, the alkali formed being much heavier than its metallic base. It appears that, to produce the ignition, the charcoal should not only be reduced to powder soon after its formation, but that the sooner it is so reduced the more certain and considerable will be the effect. Now, this fact also is entirely consistent with the explanation, because, when the pulverization has been delayed, air and moisture will have gradually produced the alkali, by a process imperceptible, because the minute portions of potassium would be at comparatively distant intervals from each other, and thus would not be in sufficient quantity at any one place to produce a sensible effect.

Colonel Aubert pulverized a mixture of coal and sulphur, and he found that under these circumstances no ignition ever occurred. The reason is obvious: for the potassium, which has been conceived to be the cause of the combustion, entered during the

trituration into combination with the sulphur.

He also triturated charcoal with nitre, and he again found that the spontaneous combustion was prevented. Now nitre, by mingling with the potassium, would check its too rapid absorption of oxygen; and the effect of his experiment is in this way sufficiently accounted for.

The presence of the potassium seems to account for the circumstance, that when charcoal is moistened and subjected to heat, carburetted hydrogen is set at liberty. In this instance it would appear that the water is decomposed, the hydrogen evolved, and the oxygen united with the potassium to form the alkali. If the heat be continued, carbonic oxide would be evolved; the oxygen absorbed in the first part of the operation being again detached from the metallic base. Now this explanation corresponds precisely, I believe, with the order in which, in such an experiment, these gases are produced.

All these circumstances observed by Mr. Hadfield and Colonel Aubert appear, therefore, perfectly reconcilable with the supposition that the spontaneous incandescence is owing entirely to the oxidation of the potassium liberated from the wood during the manufacture of the charcoal.

Dr. Thompson, in the second volume of his History of Chemistry, published since my paper was read to our society, has thrown additional plausibility upon my explanation, by his attempt to show that phosphorus owes its property of catching fire, when in contact with oxygen, to a little potassium, which is reduced to the metallic state during the formation of the phosphorus.—[Phil. Mag.]

Correct Fusing Points of Metals and Alloys, and other important Temperatures, upon various Thermometrical Scales. [From the Repertory of Arts, &c.]

In the thirteenth edition of Parkes' Chemical Catechism, edited by Mr. Brayley, jun., which has just appeared, we find a "Table of the Effects of Heat," (p. 606), in which the higher temperatures have been corrected by the editor, agreeably to the pyrometrical researches of Mr. Daniell and other chemists. As we do not remember to have seen any connected view of the results, as to the correct fusing points of metals and alloys, &c., which Mr. Daniell has obtained by the use of his new register pyrometer, we subjoin an extract from this table, containing the temperatures from 212° upwards. It may be requisite to state, for the information of such of our readers as may not be acquainted with the present state of pyrometry, that Mr. Daniell has shown (as we find it explained by Mr. Brayley at p. 70, *notes*, of the Chemical Catechism,) that "the degrees (above the zero of 1077° Fahrenheit, which is stated to be a red heat visible in the daylight,) of Wedgwood's pyrometer, instead of being equal to 130° of Fahrenheit, as supposed by its inventor, are equal only to about 20°;" and that consequently the *range* of that instrument, instead of including 3200 degrees of Fahrenheit, did not really include more than about 5000°: this will account for the great difference of the corresponding temperatures of Fahrenheit, &c., and Wedgwood, as here stated from the new edition of the Chemical Catechism, from those given in former editions of that work, and also in many other publications on chemical subjects.

Fusing Points, &c. on the scales of	Fahr.	Reau.	Cent.	Wedg.
Water boils, and "fusible metal" [$\frac{8}{16}$ bismuth, $\frac{5}{16}$ lead, $\frac{3}{16}$ tin, smelt]	212	80	100	
Sulphur melts	216	89	111	
Nitrous acid boils	242	93	116	
Camphor melts	288	114	142	
Sulphur burns slowly	303	120	150	
Pewter melts, [lead $\frac{1}{5}$, tin $\frac{3}{5}$,]	403	165	206	
Tin melts	442	182	227	
Type metal melts, [lead 16 parts, antimony 1,]	507	211	264	
Sulphuric acid (sp. gr. 1·848) boils	590	248	310	
Lead melts	612	258	325	
Mercury boils	662	280	350	
Zinc melts	773	329	412	
Iron bright red in the dark—hydrogen gas burns?	800	341	427	
— red in twilight	884	386	475	
— red heat in daylight	1272	551	700	
Enamel colors *burnt*, or *burnt-in*,* on porcelain,	1392	605	756	6
Bronze melts, [copper $\frac{3}{4}$, tin $\frac{1}{4}$,]	1446	629	786	
———, [copper $\frac{7}{8}$, tin $\frac{1}{8}$,]	1534	668	835	
Diamond burns?	1552	676	845	14
"Orange heat" (Prinsep)	1650	719	899	
Brass melts, [copper $\frac{1}{2}$, zinc $\frac{1}{2}$,]	1672	730	911	
———, [copper $\frac{3}{4}$, zinc $\frac{1}{4}$,]	1690	737	921	21
Bronze melts, [copper $\frac{15}{16}$, tin $\frac{1}{16}$,]	1750	794	955	
Silver melts	1873	818	1023	28
Copper melts	1996	860	1091	
Gold melts	2016	862	1102	
Delft-ware fired	2072	967	1179	40
Cast iron melts	2786	1224	1420	
Cream-colored stone-ware fired	2992	1316	1645	86
Temperature of the maximum of expansion of platinum, be-				

* This is a technical term used by enamellers, glass and porcelain painters, &c., to denote the fixing of the colors they employ, by means of vitrifaction, on the substances painted upon.

Fusing Points, &c on the scales of	Fahr.	Reau.	Cent.	Wedg.
ing nearly the highest degree of heat attainable in a laboratory wind-furnace, .	3280	1444	1805	
Flint glass furnace, greatest heat ? . . .	3552	1253	1956	114
Soft iron melts, according to Clement and Desormes, but in all probability an estimate considerably above the truth, . .	3945	1406	2118	

Mr. Brayley observes, at the end of the table, "The still higher temperatures, derived from the experiments of Mr. Wedgwood, which were here given in former editions of the Chemical Catechism, are now omitted; a comparison of them with the results obtained by Mr. Daniell, by means of his pyrometer, having shown that they cannot be relied upon. Some of the temperatures given in this Table above that of ignition, or 800°, must also be regarded as doubtful, and all of them must be regarded as approximative merely.

Proceedings of the Royal Institution, London Feb. 14, 1834—*Evening Meeting*. [From the London Repertory of Arts, &c.]

Dr. Faraday gave a conversation on Ericsson's Caloric Engine. He commenced by stating that he felt himself placed in a position of considerable difficulty, in bringing forward a subject on which such difference of opinion existed; yet the object of this institution was the philosophy of a question, not to decide on the probable result in a mercantile point of view, of any invention or engine which might be brought forward, and in explaining the principles of Captain Ericsson's invention, he trusted that he should not be held responsible for the correctness of the various propositions which he would have to make; at the same time, he was bound to state that, prior to the construction of the engine, one part of the invention was submitted to his opinion, and he had reported favorably; and this was the possibility of transferring the heat contained in a current of air passing in one direction to another current of air passing in an opposite direction (separated only by metallic surfaces); but how far this might be usefully and economically employed in obtaining an engine of power, it was not for him to determine; this question would be brought to a fair test when an engine of 50 horse power, now constructing, shall be set to work. Dr. Faraday then described the manner of transferring heat from one current of air to another by working models, and afterwards, by the aid of working diagrams, he explained the construction of Captain Ericsson's engine. Our having given a full account of this engine at page 42 of the present volume,* will render it unnecessary again to describe the principles on which this invention is proposed to work. Dr. Faraday having explained the various bearings of the question, concluded by observing that he was bound, in justice to his own character, to make a remark, which he regretted the more that it was possible and probable, had he been able to see Captain Ericsson prior to his entering into this explanation, he would have been able to remove a doubt and difficulty which he (Dr. Faraday) must confess he could not clear up to his satisfaction; this had been prevented by the serious illness of Capt. Ericsson. What he referred to was, that he could not clearly see how the difference of pressure, stated by the inventor to exist, could be maintained in the different parts of the apparatus.

INSTITUTION OF CIVIL ENGINEERS.—The following are the subjects which have been under discussion at the Tuesday evening meetings:

"What are the advantages to be derived from the application of undulating railroads?"

After a full discussion (lasting two evenings), in which many of our best and most talented men took part, this question was dismissed with a general expression, that there were no advantages to be derived, but, on the contrary, a decided loss.

"Heating power of coal and other kinds of fuel: Have any experiments been made, or data collected, from which can be calculated the number of cubic feet of atmospheric air which one pound of good Newcastle coal will raise 1° of Fahrenheit?"

This subject has called forward considerable information, but nothing final has been determined on; but so far as we are able to judge, Tredgold's calculations may be depended on for their correctness.

"Velocity of currents of air: Is there any instrument for measuring correctly the velocity of air in motion; and if so, upon what principle does its action depend?"

Mr. Barwise explained an instrument constructed by him for this purpose, and promised to construct one for the institution.

The following are the subjects which stand next for discussion:

"Grouting masonry and brickwork: The application of it—how and when it ought to be used—the materials for it."

"The worm in the timber of piles, &c.: Driven in salt water, and the means of preventing it."

"Lock gates and sluices: With any late improvements in the materials or construction."

"Steam: Any substitute for it—Ericsson's caloric engine."

---

* For notices of this engine, see pages 65 and 181, vol. iii., of this Magazine.

THE *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. MINOR and J. E. CHALLIS, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 25¼ cents—in volumes of 384 pages, in cloth boards at $1.75—or at $3 per annum *in advance*.—JOHN KNIGHT, (formerly proprietor of the London Mechanics' Magazine,) Editor.

MECHANICS' MAGAZINE,

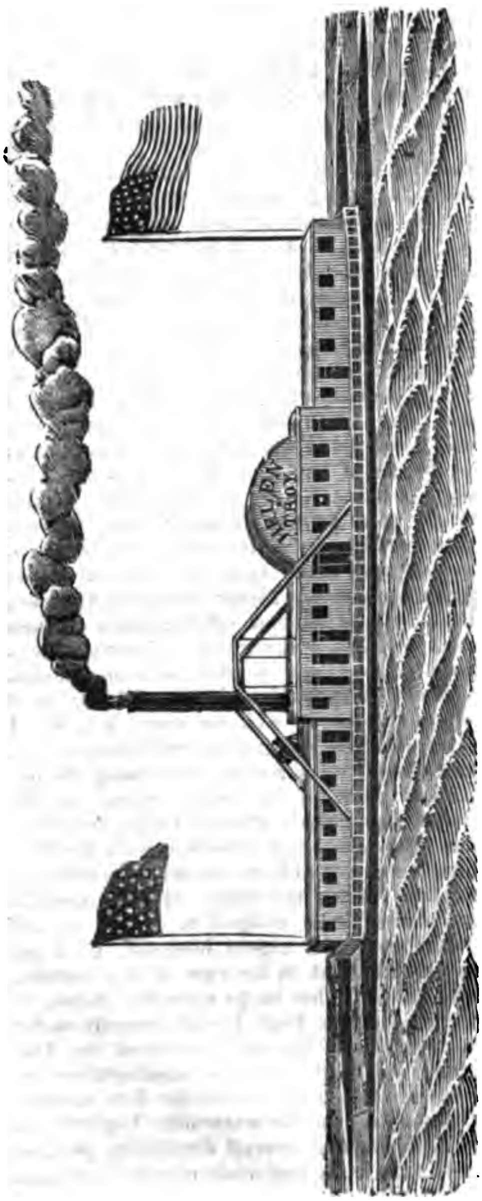
AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FOR THE WEEK ENDING JUNE 14, 1834. [NUMBER 6.

"All men naturally think themselves equally wise; and therefore, as any ship that sails faster than another is said, in sea phrase, to wrong it, so men are apt to think themselves wronged by those who, with better talents than they, or greater skill in their use, get beyond them."—HARTLIB.

NEW ERA OF STEAM POWER.



BURDEN'S BOAT.—This "wonder of the age" made its second trial on Wednesday last, June 10th. We have all along expressed our conviction that Mr. Burden has stated nothing that he will not accomplish; we think so still, and so does every practical man we have conversed with on the subject. But we do hope, that Mr. B. will not allow his anxiety to realize his promises interfere with his judgment, or in any way prevent his doing that which he has promised to accomplish, WELL. We insert the annexed engraving as a correct representation of it, and take this opportunity of introducing to the notice of our readers a condensed account of steam engines and their inventors, compiled from authentic sources. In a few days she will make her first trip to Troy.—[ED. MECH. MAG.]

Burden's Steamboat. By ARCHIMEDES. To the Editor of the Mechanics' Magazine, and Register of Inventions, &c.

SIR,—I wish, through the Magazine, to offer a brief apology for the disastrous consequences of my communication in a preceding number, respecting Harris' (patent-secured) twin-boat.

I solemnly protest, I had no disposition to wound the feelings, much less to disturb the intellect, of Mr. H. Had I anticipated that such would be the effect, or that it would cause the exclusion of interesting matter from a succession of pages of the Magazine, I certainly would not have written a word. It is some alleviation, however, of the trouble I feel on the occasion, that Mr. H. gives me credit for affording him "no little amusement," and that he absolves me of any criminal intention.

I must beg of Mr. H. to make a further

extension of his magnanimity, and pardon my stupidity in not at once discovering the dissimilarity of his and Mr. Fairman's twin-boat, when Mr. H. has not only described, but invites the reader to "imagine [he sees] a boat extremely long, very narrow, with a flat bottom, similar to river steamboats of the present day—very short, with fine tapering extremities, with the stem and stern posts in curvilinear shape, and both inclined in opposite directions, as in common vessels, but in very acute angles with the horizon. You have now," he tells the reader, "only to imagine this boat split into two equal parts longitudinally," &c. Now, what a numbskull I must have been not to see the difference. 'Tis true, Mr. F.'s boat was *very narrow*, with a flat *bottom*, *similar to river* steamboats of the present day, &c. and it was split in two from stem to stern: so far they were alike; but Mr. H.'s imaginary boat was extremely long, whereas Mr. F.'s was only 35 feet. Mr. H.'s had fine tapering extremities, and I do not know that Mr. F.'s had any finery about it.

But, with great deference, I would beg leave to state that Mr. H. has misunderstood me in some trifles. I did not state, or, at any rate, I did not mean to state, that Mr. F. made his boat go 105 miles per hour; I only stated, that by Mr. F.'s making the alteration from straight to *swelled* sides, if Mr. H. will pardon the expression, the result was a gain in speed with the same power, from 4 to 6 miles per hour; that is, she would go but 4 miles before the *swell*, and she went 6 miles afterwards, with the same power. Mr. F. supposed that, as the water was thrown back from the wheel, by giving it a diverging passage, it would leave the boat more freely. [Perhaps he was wrong.] I would also inform Mr. H. that there are times when there is not a "six knot sailing breeze" in the sound, between the mouth of the Connecticut and New-London. Perhaps Mr. F. took such a time; at any rate, all the facts respecting his boat are susceptible of abundant proofs.

Mr. H. concludes with several statements, which he says I must in candor allow. To which I beg leave to reply, that as he has condemned Mr. Burden's boat, if he will have the lenity to respite the execution of his sentence until Mr. B. can satisfy me and the public by a fair experiment, I will never trouble him again, and will try to believe, and, at any rate, allow, whatsoever he pleases—and that he shall not hear again from

ARCHIMEDES.

Lansingburgh, May 27, 1834.

The Great American Steam-Raft of English Origin. By ALFRED CANNING. [From the London Mechanics' Magazine.]

SIR,—Having noticed in your Magazine for Saturday, 22d ult., an account of a raft propelled by steam, considered to be the invention of a Mr. Burden, in America, I think it due to myself to state, that in 1817 I conceived the idea of constructing a raft similar to that attributed to Mr. Burden, with this difference, that the bows of my floaters were to be considerably more elevated than those of Mr. Burden's raft. The following year, being in Paris, and foreseeing the probability of being detained there for a considerable time, I set about constructing my raft. I took two deal planks, of 30 feet long each, 12 inches wide by 6 inches thick, and having fashioned each like a canoe, I placed them on edge, parallel with each other, about 5 feet asunder, and connected them together at about 3 feet from the surface of the water, by a decking resting upon 4 stanchions, of about 7 feet long, which rose nearly 4 feet above the deck, and served to support a handrail, as well as to maintain in square the whole frame-work, by diagonal ropes, which passed through holes in the tops of the stanchions and holes in the deck. I tried this little model raft, both with oars, a sail, and paddle wheels (worked by the feet), and found that I was not deceived in my expectations of its speed, which was astonishing. I had a rudder of sheet iron, in the shape of a fish tail, adapted to each side-piece or floater, which were connected together and acted upon by diagonal cords and a cross-bar. Prince Joseph de Chimay, his sons, and several other persons of high rank, witnessed my trials. Finding it succeed so well, and possess so many advantages over every description of boat, as it was not liable to sink or upset, &c. &c. I determined to construct a much larger raft, and propel it by steam; but owing to the jealous spirit of the boat owners on the Seine, particularly Prosper-Colin, and Dagnet, who had great influence with the Prefect, I was not able to procure a permission to place it upon the river. Being immediately afterwards obliged to absent myself from Paris upon urgent business, I left my model raft afloat, in the care of a waterman, who lived in his barge upon the Seine, at the foot of the Pont Royal, directly under the windows of the royal palace of the Tuileries, one of the greatest thoroughfares in Paris, where it remained for five months. Upon my return, the waterman (Laporte) informed me that several foreigners, particularly Americans, had made repeated inquiries

respecting the nature of the raft, and that *two American gentlemen had made drawings of the raft*; and had observed, "that rafts constructed upon the same principle would suit well the lake navigation in the United States."

Should you, Sir, or any of your readers, feel desirous of seeing a sketch of my sail or steam raft, and further particulars respecting that, and four others which I constructed subsequently, having varied the dimensions of the floaters, and the substance of which they were composed, I will furnish them with pleasure. I remain, sir, your most obedient servant,

ALFRED CANNING.

Crown Coffee-House, Holborn, March 18, 1834.

[We shall be glad to hear again from Mr. Canning on the subject, with drawings, not only of his original model, but of his more matured plans of construction, and all illustrative particulars.—ED.]

NOTE.—Since the article in our present number, on the great American steam-raft was in type, we have received a letter from an esteemed correspondent, from which the following is an extract: "The velocity attained was in *still* water. The vessel draws only 7 *inches* water. They expect, with another that is completing, to perform *twenty-seven* miles an hour."

Account of Steam Engines and their Inventors.

[Compiled from authentic sources.]

The elegant toys of Hero, the beautiful experiments of Porta and Decaus, the modifications of the Greek machine by the unknown Italian, the practical merit of the "water-commanding engine," the ingenious ideas of Hautefeuille, and their masterly extension and developement by Papin, contain all the rudiments required for a perfect machine, waiting only to be touched by the wand of some mechanical magician, to form a structure of surpassing ingenuity and semi-omnipotent power.

The total neglect with which these individual schemes were regarded is not the least extraordinary circumstance in the history of the steam engine, and, above all, the oblivion which followed that of Lord Worcester, whose unconquerable perseverance, at the lowest ebb of his fortune, found means to carry his splendid ideas into practice. It appears improbable, but that his mechanism, whatever it was, was forced upon the attention of many parties connected with the draining of mines; and from the character of the Marquess, it is equally remote from belief that he would fetter the introduction of his invention into general use, by a high price asked for his permission to use it. The utter novelty of the nature and power of the agent, an ignorant and absurd idea of its danger, and the total want, probably, of any mechanical means, except that of mere strength of parts to guard against accidents, may have been the real causes of its neglect, and exclusion from practice.

Thirty years after Lord Worcester's death, a brilliant ray of improvement suddenly bursts into the history of the steam-engine, from the consummation of the labors of a Captain Thomas Savery, who had been silently employed in combining a mechanism, in which elastic vapor was the motive power.

Of the history of this distinguished man little is known. * * * *
He is first presented to our observation as an author of a scheme for rowing ships in a calm, for which, after obtaining a patent, he in vain endeavored to procure the patronage of Government. "The trial of my scheme was unjustly thwarted by one man's humor," said Savery. "A regard to my duty, as well as place, will not permit me to give a biassed opinion," said the umpire. "But I have tried it," replied the projector, "in a small scale, and it answered completely." "So have we," said the servants of Government, "and in our trial it failed completely."

Savery afterwards remarked: "I was necessitated to write my book; for after I had racked my brains to find out that which a great many have spent several years in vain in the pursuit of, when I had brought it to a draught on paper, and found it approved by those commonly reputed ingenious, and receiving applause, with promises of great reward from court, if the thing would answer the end for which I proposed it; after I had, with great charge and several experiments, brought it to do beyond what I ever promised or expected myself, at last one man's humor, and more than a humor, totally obstructed the use of my engine, to my no small loss; but it is the nature of some people to decry all inventions, how serviceable soever to the public, that are not the product of their own brains."

He gave an account of it to secretary Trenchard. "A few days after, the secretary told me that the king had seen my proposals, and that I need not fear, for that the king had promised me a very considerable reward, and that I must go to the lords of the admiralty to put it in practice; but that *first* I must make a *model of it in a wherry*, which I *did*, and found it to answer my expectations. Then I showed a draft of it to the lords of the admiralty, who all seemed

to like it, and one amongst them was pleased to say that it was the best proposal of the kind he ever saw; so I was referred from them to the commissioners of the navy, who all seemed to like it, but told me that the model must be surveyed by Mr. D——, the surveyor of the navy, whose opinion I asked; but he was very reserved, and said, 'that a wherry was *too small a thing* to show it in, there being no working at a capstan in a wherry;' but he told me 'it was a thing of moment, and required some time to consider on; for should I,' said he, 'give a rash judgment against it, I should injure you; or for it, the charge of putting it in practice must prove a loss to the king, and endanger my employ.'"

After four months' consideration, Dummer gave his opinion against Savery. It was neither a new nor a practicable invention, being similar to one used at Chatham, in 1682, which was abandoned, and he designated, though rather disingenuously, the capstan and its trundle as "*clock-work*;" and although Savery "exhibited his wherry on the Thames, and thousands of people were eye-witnesses, and all people seemed to like it, the public newspapers speaking very largely of it, yet all to no purpose." (p. 18.) The inexorable lords of the admiralty were "so much altered that, from commending the thing, they would not hear one word in its defence." (p. 15.) Savery, notwithstanding, "being informed by Sir Martin Beckman, the greatest engineer in the Christian world, that the thing was good, got a noble lord to show a draft of it to the king a second time, who ordered me," says Savery, "again to the admiralty, who never ordered me in before them, but, after waiting two or three days, the doorkeeper told me that my business lay before the *navy*. Upon which, next day, I desired a friend of mine to go with me to the navy office, that he, being a man of extraordinary judgment, and no less reputation, might be an evidence to what discourse might happen; but coming to the navy office, we found the board was rose. However, in the hall I found Mr. D——; I asked him whether any thing was come before the board concerning my business. 'No,' said he, 'not since the objections sent to the lords of the admiralty;' on which he could not but fall into an argument. I asked him some questions in relation to his objections, and in a very little time we had a great puther about superambient air and water. I found that my sailor ran himself fast aground, as men commonly do when out of their knowledge; this, indeed, made me pity him again, although I was willing to come at the plain truth of the matter, and asked him whether or no he could not bring one hundred and fifty men to work at this engine, he answered yes; then, said I, will they not have as much power to give a ship motion as one hundred and fifty men would have on shore, at a hawser fastened to the ship; this he likewise answered in the affirmative. Then, said I, it will do more than oars, or any thing but a gale of wind, and fully answer my proposals. Well, said he, with a smile, and putting off his hat as taking leave, 'WE are all submission to the lords of the admiralty.'

"Not long after, a friend of mine met a commissioner of the navy, and my friend, being perfectly acquainted with my contrivance, asked the commissioner why it was not put in use by them? The gentleman offered several objections, which were, by sound reason, fully answered by my friend, that he had only this hole to creep out at. 'Sir,' said he, 'have we not a parcel of ingenious gentlemen at the board?' 'Yes,' said my friend, 'I hope so, or five hundred pounds per annum is paid them to a fine purpose.' 'Is not Mr. D——,' said the commissioner, 'one of them, and an ingenious man?' 'I hope so,' continued my friend. 'Then,' said he, 'what have interloping people, that have no concern with us, to pretend to contrive or invent any thing for us?'"

Savery, whose bluntness, probably, was no recommendation to his application, has several flings at the "boards," and his statement is wound up by a dexterous one at the contents of courtly Dummer's wig. "Whoever is angry with truth for appearing in mean language, may as well be angry with a wise and honest man for his plain habit; for, indeed, it is as common for lies and nonsense to be disguised by a jingle of words, as a blockhead to be hid by abundance of peruke."—[Navigation Improved, p. 33.]

In the pamphlet in which Savery appeals from their judgment to that of the public, he pays less attention to the reasons urged against its novelty, as well as practicability, than they were fairly entitled to receive.* In his resentment he says, that "not a tittle will he disclose of two other inventions of his until he has justice done him on account

* *Navigation Improved*, or the art of rowing ships of all rates, in calms, with a more easy, swift, and steady motion than oars can, by *Tho. Savery*, gent. London, 1698. In 1693 a M. Duquet made several experiments at Marseilles, at the expense of the King of France, to navigate a vessel by revolving paddles, or wheels, instead of oars. The results of these trials were very satisfactory, and strongly directed the attention of philosophers, as well as mechanics, to the practicability of this application of water-wheels.—[Machines Approuvees, tome i. p. 173.]

of his rowing engine." The first of these was "a gin of fourteen inches square, portable by one man, and by which one man may lift the largest cannon into her carriage." The second contrivance was a method whereby he could fight any ship, "using charge and discharge as often as six do now, and to as much purpose, without any manner of incommodation, more than by the common way, so that one half of the men need not be exposed that now are, and the rest may be kept as a reserve for boarding; the benefit of this I leave to the ingenious sailor."†

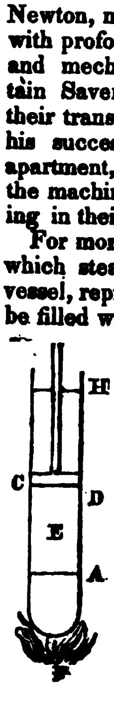
The enthusiasm of the projector was softened in Captain Savery by the experience of a practical mechanic; and he early appears to have acquired that personal consideration which usually follows a man of genius and enterprize, when his habits are those of a man of business.

At the first announcement of his machine for raising water, he had so matured his ideas, and was so well versed in the nature and power of the motive agent, that his masterly combination has left but minor objects for improvement to succeeding engineers. His mode also of introducing his invention to the notice of the public was totally different from that which had been followed by former projectors. They enveloped every thing in mystery, and endeavored to attract attention by exaggerated statements of power or economy. His first step was to explain to every one the principles, as well as construction, of his apparatus: he showed why it was a cheaper power than that of horses or men; and he invited practical men to judge for themselves of the value of his assertions and statements, by an inspection of the machine itself in operation.

The influence of the court was at this period considered to be essential to the success of any speculation which required the aid of a monopoly. The profits might be diminished or overthrown by the obstacles which avarice and intrigue could then interpose in that quarter to its further progress; and from this circumstance, considerable importance was attached to having the countenance of those in power to any project in which the pecuniary risk required to be extensive; and Captain Savery might be said to be conforming to an almost common practice, when he exhibited a working model of his fire engine before King William, at Hampton court. That monarch, who himself had a mechanical turn, was so pleased with its ingenious construction and effective action, that he took a warm interest in its success, and permitted its author to inscribe to him the account which he published of his contrivance, under the title of "The Miner's Friend."

The great fame of the Royal Society, then adorned by the presidency of Sir Isaac Newton, made its opinion to be listened to with profound respect in matters of science and mechanics. To that body also Captain Savery carried his invention; and in their transactions for that year is a record of his successful experiment, made in their apartment, and a view and description of the machine forms the subject of an engraving in their annual volume.

For more perfectly illustrating the mode in which steam operates, we will suppose the vessel, represented in the following figure, to be filled with water up to the line A, and the



space E occupied with air, and having a plug or piston fitting it at C, and an aperture at D; now, if the aperture D be closed, and heat applied to the water, as at F, steam will be generated, and by its expansive force will raise the piston C upwards; then, if the heat be withdrawn, and the vessel suddenly cooled, condensation will take place, the steam, reassuming the form of water, will again occupy the space below the line A, and the piston C will re-

† Sir Isaac Newton, in a report (dated Leicesterfield, January 27, 1718,) which he made to the government, on the practicability of an invention for measuring a ship's way at sea, mentions Savery as the *inventor* of this machine, and notices another of his contrivances. "Mr. Savery, who invented the raising of water by fire, told me about six years ago, that he had invented an instrument to measure the distance sailed, and by his description that instrument was much like this, (the one submitted for his opinion,) the sea water driving round the lowest and swiftest wheel thereof, and that wheel driving round other wheels, the highest and lowest of which turn about an index to show the length of the way sailed."

Savery complained of one of his inventions being neglected, from its resembling a mechanism with which he was unacquainted; but Savery's one, which is now mentioned, was itself only a copy from another described by Bourne, in his inventions as produced by a Humphrey Cole. De Saumarez complains, in his turn, of Savery's scheme being remembered by Sir Isaac only to get rid of his claim. The picture he draws of his pursuits and projects is an excellent likeness of a large but harmless class —can it be named ?—of *simple schemers.*

"He was the son of De Saumarez, chaplain to Charles II.; although he was bred in Holland to learn commerce, he never applied himself to any trade or profession, but in an *easy and quiet enjoyment* of his small estate, in the island of Guernsey, he took his diversion in the experimental part of mathematics, his genius or inclination being that way for machines and inventions, wherein he spent about 22 years last past, confining himself to a retired sort of life, within his little laboratory; and of late he fixed his projects upon a particular invention, towards the improvement of navigation, which he could not bring forth to effect in the island, for want of able workmen; but he came to London on purpose, and he hath actually begun, and hopes, with the blessing of God, to bring it to some perfection."—[Memorial, p. 4.]

turn to its place. In this experiment the expansive force of the steam compressed the air in the space E, and forced the plug C upwards, we will suppose, to H; but C, in travelling to H, displaced so much of the atmosphere as occupied the tube from C to H; consequently, the portion so displaced will seek to resume its natural position, and when the force of the steam is withdrawn by condensation, the weight of that portion of the atmosphere will again return the plug C to its place; by which it is obvious that the raising of the plug was the direct action of the steam, and the returning its consequent action, or the action of the atmosphere, in consequence of its having been displaced by the force of the steam.

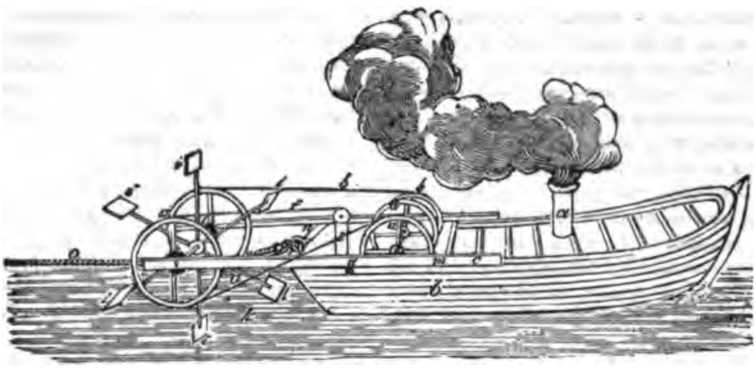
Again, if we suppose the plug to be in its first situation, as at C, and we open the aperture at D, and apply heat, the steam will rise into the space E, and expel the air through the aperture D, which being closed, and condensation caused, the space E will be left a vacuum, and the atmosphere seeking to occupy that space will force the plug C down to the line A; here the movement of the plug C was solely caused by the atmosphere exerting itself to regain the position whence it had been expelled by the force of the steam through D, and this effect is performed by the consequent power of steam alone.

It has been found by experiments, that the pressure of the atmosphere is equal to about 14 pounds weight upon every square inch, so that supposing the superficies of the aperture of the vessel, to contain one square inch, the power exerted by the steam in raising C to H will be tantamount to raising 14 pounds weight that height, together with the power necessary to overcome the friction and weight of the piston C, in the cylinder; and that the power exerted by the steam in expelling the atmosphere from the space E, and obtaining its consequent pressure to the raising of 14 pounds from A to C; and that the disposable power, obtained by the return of the piston from H, will, in the first instance, be equal to the raising of 14 pounds weight from C to H, less the amount of the friction of the piston C; and, in the second, will be equal to the raising of 14 pounds weight from C to A, less the amount of the friction as before. In both these instances the expansive or direct force of the steam has only been considered as equal to the displacing of the atmosphere, or what will be equal to 14 pounds pressure on each superficial inch; but if the piston C be loaded with any weight, the steam will, if urged with sufficient heat, raise it, always premising that the vessel is strong enough to resist the increased pressure. Suppose C to be loaded with 10 pounds of weight, the steam must be urged until its pressure is equal to 24 pounds, 10 pounds more, 14 pounds the pressure of the atmosphere on each square inch, and the resulting disposable force will be equal to 24 pounds more, the weight of C, less its friction returning to the place from where C was raised; so that, in this case, the pressure on the internal sides of the vessel, tending to burst it, will be equal to 10 pounds per square inch of the internal superfices, the remaining 14 pounds being counteracted by the pressure of the atmosphere on the external surface, which is equal to 14 pounds of the internal pressure. By this, it is evident that the direct force of steam may be increased without limits, whereas the resulting force or pressure of the atmosphere is manifestly bounded to 14 or 15 pounds on the square inch, according as its density varies.

A mode of applying the power of a steam-engine to navigate a vessel was suggested by Jonathan Hulls in 1737.* But the scheme, although a nearer approach to the present form of the steamboat, can neither be considered as the first suggestion for moving wheels by steam, nor any improvement on the idea which emanated from another—nor even any specimen of mechanical skill, for it is awkward, clumsy, and inartificial; but, as his claims have been put forth to a higher place than is here assigned him, they will be better understood by a reference to the engraving, (see following page,) and the description of it, which follows nearly in his own words. It is doubtful whether Hulls ever proceeded beyond printing a description of his project.

"*a*, chimney coming from the furnace; *b*, tow-boat; *c*, *c*, two pieces of timber framed together to carry the machine, *d*; *x*, *y*, *z*, three wheels on one axis to receive ropes, *s*, *t*, *u*; *t*, being rope that goes into cylinder; *m*, *n*, two wheels on same axis with the fans, *i*, *i*, *i*; *u*, is a rope going from wheel, *n*, to *z*; that, when the wheels, *x*, *y*, *z*, move forward, moves wheel, *n*, forward, and the fans along with it; *s*, a rope going from wheel, *m*, to the wheel *x*, so that when the wheels, *x*, *y*, *z*, move forward, the wheel, *m*, draws the rope, *s*, and raises the weight, *g*, at the same time as the wheel, *n*, brings the fans forward.

* A description and draught of a new-invented machine for carrying vessels or ships out of or into any harbor, port, or river, against wind or tide; or in a calm. London, 1737. It is a pamphlet, by no means scarce, containing forty-eight pages, about eight of which have any reference to his invention. Hulls took out a patent.



"When the weight, *g*, is so raised, while the wheels, *x*, *y*, *z*, are moving backward, the rope, *s*, gives way, and the power of the weight, *g*, brings the wheel, *m*, forward, and the fans with it, so that the fans always keep going forward, notwithstanding the wheels, *x*, *y*, *z*, move backwards and forwards as the piston moves up and down in the cylinder: *o*, *e*, teeth for a catch to drop in from the axis, and are so contrived that they catch in an alternate manner, to cause the fans to move always forward; for the wheel, *m*, by the power of the weight, *g*, is performing its office while the other wheel, *n*, goes back, in order to fetch another stroke. The weight, *g*, must contain but half the weight of the pillar of air pressing on the piston, because the weight is raised at the same time as the wheel, *n*, performs its office; so that it is, in effect, two machines acting alternately by the weight of one pillar, of such a diameter as the diameter of the cylinder is." Hulls, aware that objections might be urged against its want of originality, endeavors to anticipate them: "if it should be said," says he, "that this is not a new invention, because I make use of the same power to drive my machine that others have made use of to drive theirs for other purposes, I answer, the application of this power is no more than the application of any common and known instrument used in mechanism for new invented purposes."

It may, however, be observed, that he considers that it would not be practicable to place his apparatus on board of the ship which it is required should be moved—but that a separate vessel should be appropriated to its reception, and that this should be used as a tow-vessel; and he urges several economical reasons in favor of his *Tow-Boat.* The manner of converting the rectilineal motion of his piston into a rotary one, is very ingenious.*

Next in order we must place the experiments of the immortal James Watt.

From results, he saw that, in order to make the best use of steam, it was necessary that the *cylinder should always be as hot as the steam which entered it.* And also, that all the water that was formed by the condensed steam, and the injection-water likewise, should be cooled down to 100 degrees, or lower, where that was possible.

In looking to what had been done, or suggested by others, he had little to guide him in this inquiry. A rude help to his ingenuity might have been derived from some of the most common experiments with the air-pump; but at the moment when his sagacity had pointed out the direction of the path, his imagination did not enable him to follow it.

He had yielded to the difficulty, when, early in 1765, "in one of those moments when the heavenly spark of genius shone with brightness in his mind, the idea broke in upon him," that if a *communication were opened between a cylinder containing steam and another vessel which was exhausted of air, the steam would immediately rush into the empty vessel, and if that were kept very cool, by an injection or otherwise, the steam would continue to enter until the whole was condensed. And if an air-tight cover were placed on the cylinder, steam might be admitted to depress the piston in a vacuum instead of the atmosphere.* Admirable Invention!

When once the idea of separate condensation was started, minor improvements followed in quick succession. He imagined that the orifice for the piston-rod could be kept air-tight by means of a stuffing-box; and as it was obvious water could not be introduced to make the piston steam-tight, for if any of it found its way into a hot cylinder

---

* About this period three fire-engines were in operation in France, one at Fresne, near Conde; one at a coal mine at Sars, near Charleroi; a third at a lead mine near Namur.—[Gensanne, p. 300, vol ii. Machines Approuvees.]

it would be converted into vapor, (as in some of his experiments,) he should employ wax and tallow as lubricating substances. He also thought that, by surrounding his cylinder with a casing of some substance which would prevent its heat from being abstracted by the circumambient air, and the air which was disengaged from the water, or found its way into the cylinder, he could extract by a pump, and by the same means he might employ the condensing vessel of the water which was produced by the injection and the condensation of the steam, or he would allow it to fall through a pipe thirty-four feet long into a pump or well, as practised by Newcomen and others. Thus, step by step, in the course of one or two days, in the eye of his mind, the exquisite conception was complete.

"About the time that Mr. Watt was engaged in bringing forward the improvement of the engine, it occurred to Mr. Gainsborough, the pastor of a dissenting congregation at Henley-upon-Thames, and brother to the painter of that name, that it would be a great improvement to condense the steam in a vessel distinct from the cylinder, where the vacuum was formed, and he undertook a set of experiments to apply the principle he had established, which he did by placing a small vessel by the side of the cylinder, which was to receive just so much steam from the boiler as would discharge the air and condensing water, in the same manner as was the practice from the cylinder itself, in the Newcomenian method—that is, by the snifting valve and sinking pipe. In this manner he used no more steam than was just necessary for that particular purpose, which, at the instant of discharging, was entirely uncommunicated with the main cylinder, so that the cylinder was kept constantly as hot as the steam could make it. Whether he closed the cylinder as Mr. Watt does, is uncertain; but his model succeeded so well, as to induce some of the Cornish adventurers to send their engineers to examine it; and their report was so favorable as to induce an intention of adopting it. This, however, was soon after Mr. Watt had his act of parliament passed for the extension of his term; and he had about the same time made proposals to the Cornish gentlemen to send his engine into that country. This necessarily brought on a competition, in which Mr. Watt suceeeded; but it was asserted by Mr. Gainsborough, that the mode of condensing out of the cylinder was communicated to Mr. Watt by the officious folly of an acquaintance, who was fully informed of what Mr. Gainsborough had in hand. This circumstance, as here related, receives some confirmation by a declaration of Mr. Gainsborough, the painter, to Mr. T. More, late secretary to the Society for the Encouragement of the Arts, who gave the writer of this article the information; and it is well known that Mr. Gainsborough opposed the petition to parliament through the interest of General Conway." [Hornblower, in Gregory's Mechanics, p. 362, vol ii., first edition.]—On this statement, a writer in the Edinburgh Review observes, "We believe and hope, for the sake of the memory of a very respectable man, that the conversation is not accurately represented. It remains upon record that Mr. T. More was examined as a witness on the trial of a cause of Bolton *vs.* Bull, in 1792, at which time Mr. Hornblower himself was also examined as a witness, but on the opposite side from Mr. More. Mr. M., on this occasion, was asked, whether he had read the specification of Mr. Watt's invention, and whether, in his opinion, it contained a disclosure of the principles of the steam-engine? To this question he answered, 'I am fully of opinion that it contains the principles entirely, clearly, and demonstratively.' He was then asked, 'Did you ever meet with the application of these principles before you knew of Mr. Watt's engine?' His answer was, 'I do declare I never saw the principles laid down in Mr. Watt's specification, either applied to the steam-engine previous to his taking it up, or ever read of any such thing whatever.' It is not easy to reconcile these two answers given by that gentleman on his oath, with the words that Mr. Hornblower has put into his mouth. Mr. Gainsborough's idea, whatever it was, was posterior by more than twenty years." (?) [P. 328, vol. xiii.]—We know not if the claim which is put forth in the above extract is the same as that alluded to by the late venerable Professor Jardine. "I happened," says he, "to be tutor to Dr. Roebuck's sons at that time (when Watt was at Kinneil); I had then the pleasure of seeing the experiments on a great scale, which were carrying on. This accidental circumstance, and this opportunity, connected me so much with what was going on, that when they were completed I was asked by Mr. Watt to go with him to Berwick, when he went to give in a specification of his invention before a Master in Chancery, previous to the obtaining of a patent. And many years afterwards, when a groundless and frivolous charge was brought against Mr. Watt, *by a person who claimed a share in the invention*, I was called to give evidence of what I knew of this in Chancery. It is needless to add, Mr. Watt was triumphantly victorious."

The failure of both Fitch and Rumsey to carry their schemes into practice, as it had previously done in another, settled the dispute as to priority of invention in America.

Oliver Evans, about the same period, had been maturing a plan for using steam of an elasticity ten times greater than that employed in the condensing and atmospheric engines. And his proposal was further remarkable, as embracing a device to propel waggons on common roads, by a steam-engine instead of horses. "But all united," says he, "in condemning the scheme, except two gentlemen, (one of whom was a projector himself,) and indeed one, who has the name of a celebrated engineer, continued to oppose them for a long time after they were fully in operation."

One of his adversaries was a Mr. Latrobe, who uniformly opposed steamboat projects, as well as those for steam carriages. Fifteen years after this period, and three years before they were finally established, (unfortunately for his reputation,) he printed a report against their practicability. We quote it as containing some *facts* respecting steam navigation. "After the American Revolution, a sort of mania began to prevail, which, indeed, has not yet entirely subsided, for impelling boats by steam-engines. Dr. Franklin proposed to force forward the boat by the immediate action of the steam upon the water. Many attempts to simplify the working of the engine, and more to employ a means of dispensing with the beam in converting the libratory into a rotary motion were made. For a short time a passage-boat, rowed by a steam-engine, was established between Bordentown and Philadelphia, but it was soon laid aside. The best and most powerful steam-engine which has been employed for this purpose, (excepting, perhaps, one constructed by Dr. Kinsey, with the performance of which I am not sufficiently acquainted,) belonged to a few gentlemen of New-York. It was made to act by way of experiment upon oars, upon paddles, and upon flutter wheels; nothing in the success of these experiments appeared to be sufficient compensation for the expense, and extreme inconvenience of the steam-engine in the vessel.

"There are, indeed, general objections to the use of the steam-engine for impelling boats, from which no particular mode of application can be free. These are—1st, the weight of the engine and the fuel; 2nd, The large space it occupies; 3rd, The tendency of its action to rack the vessel and render it leaky; 4th, The expense of maintenance; 5th, The irregularity of its motion, and the union of the water in the boiler and cistern, and of the fuel vessel in rough water; 6th, The difficulty arising from the liability of the paddles or oars to break, if light, and from the weight, if made strong. Nor have I ever heard of an instance verified by other testimony than that of the inventor, of a speedy and agreeable voyage having been performed in a steamboat of any construction."

In 1786, when Evans applied to the legislature of Pennsylvania, for an exclusive right to move land-carriages by steam, "they conceived me to be deranged," says he, "because I spoke of what they thought impossible, and they refused to grant the privilege I prayed for." The authorities of Maryland, to whom he next applied, with more wisdom than their neighbors, granted his petition, on the principle that what he asked for could injure no man, and might cause him to produce something useful." But with all his perseverance, his reputation for practical knowledge, and his privilege to boot, Evans could not persuade any person of substance to think so favorably of his steam-waggon, as to furnish him with the means to try one on a common road. And the drawings and descriptions of his scheme which he sent to England, to find a patron there, produced no better result.

The history of the result of another attempt to navigate by steam, which was made in Scotland, by Mr. Patrick Miller, of Dalswinton, has been lately given to the public by his son.* Mr. Miller, in 1787, had published a description and drawings of a triple vessel, moved with wheels, and gave a short account of the properties and advantages of the invention. "In the course of his explanations, he suggested that the power of a steam-engine may be applied to move the wheels so as to give them a quicker motion, and consequently to increase that of the ship. It may readily be believed, that this hint of his intention to apply the power of steam to the wheels of his double and triple vessels was not hastily thrown out. In the course of his various experiments on the comparative velocity of his vessels, with those propelled by sails, or by ordinary oars, which had given occasion to several interesting and animating contests for superiority, he had strongly felt the necessity of employing a higher force than that of the human arm aided as it might be by the ordinary mechanical contrivances; and in this view, various suggestions were successively adopted, and

"A short narrative of facts relative to the invention and practice of steam-navigation, by the late Patrick Miller, Esq. of Dalswinton, drawn up by his eldest son."—Edinburgh Philosophical Journal, 1824.]

in their turn laid aside. Thus, at one time, it occurred to him that the power of horses might be usefully employed; while, at another, the aid of wind itself seemed to furnish the means of counteracting its own direct and ordinary operation. But among all the possible varieties of force, that of steam presented itself to his mind, as at once the most potent, the most certain, and the most manageable."

"In Miller's family there was at this time, as tutor to his younger children, Mr. James Taylor, who had bestowed much attention on the steam-engine, and who was in the custom of assisting Miller in his experiments on naval architecture, and the sailing of boats.* One day, in the very heat of a keen and breathless contest, in which they were engaged with a boat on the Leith establishment, this individual called out to his patron, 'that they only wanted the assistance of a steam-engine to beat their opponents;' for the power of the wheels did not move the boat faster than five miles per hour. This was not lost on Miller, and it led to many discussions on the subject; and it was under very confident belief in its success, that the allusion was made to it in the book already mentioned.

"In making his first experiments, Miller deemed it advisable, in every point of view, to begin upon a small scale; yet a scale quite sufficient to determine the problem which it was his object to solve. He had constructed a very handsome double vessel, with wheels, to be used as a pleasure boat on his lake at Dalswinton, and in this little vessel he resolved to try the application of steam." On looking round for a practical engineer to execute the work, Taylor recommended a Mr. William Symington to his attention, whom he had known at school, and who had recently contrived a mode of applying the force of steam to wheel carriages; and he accompanied Miller to the house of a Mr. Robert Meason, in Edinburgh, to see the model. Pleased with this specimen of Symington's ingenuity, he employed him, in conjunction with his friend Taylor, to superintend the construction of a small steam engine, to work a double or twin boat. And in the autumn of the same year, the engine, which had brass cylinders of four inches in diameter, was fixed in the pleasure-boat on Dalswinton Loch. "Nothing could be more gratifying or complete than the success of this first trial, and while for several weeks it continued to delight Miller and his numerous visiters, it afforded him the fullest assurance of the justness of his own anticipation, of the possibility of applying to the propulsion of his vessels the unlimitable power of steam. On the approach of winter, the apparatus was removed from the boat and placed as a sort of trophy in his library at Dalswinton, and is still preserved by his family as a monument of the earliest instance of actual navigation by steam" in Great Britain.

Symington, in the succeeding year, was again commissioned by his patron to try the experiment on a greater scale; a double vessel, sixty feet long, was to be fitted with an engine and revolving paddles, suited to the supposed exigencies of the case. The engine and machinery were constructed at Carron, and in the course of six months the vessel was ready to be put in motion. In December, 1789, it was taken into the Forth and Clyde Canal, and in the presence of a vast number of spectators, the machinery was put in motion. "This second trial promised to be every way as prosperous as the first. It happened, unluckily, however, that the revolving paddles had not been made of sufficient strength, and when they were brought into full action, several of the float-boards were carried away, and a very vexatious stop was, for that day, put to the voyage. The damage was repaired, and on the 25th of December the steamboat was again put in motion, and carried along the canal at the rate of seven miles an hour, without any untoward accident, although it appeared evident that the weight of the engine was an overburden for the vessel, (her planking being only three quarters of an inch thick,) and that under such a strain it would have been imprudent to venture to sea. The experiment, however, was again repeated on the two following days; and having thus satisfied himself of the practicability of his scheme, he gave orders for unshipping the apparatus, and laying it up in the storehouses of the Carron Company."

"It may naturally occasion surprise and disappointment," continues his son, "that I should have to terminate here this account of my father's experiments on steam navigation; that he did not follow up these prosperous and decisive trials of its efficacy

* Mr. Miller at various periods of his life, had embarked in these great schemes of improvement, and, among others, had expended large sums in experiments on the improvements of artillery and naval architecture. It was in the course of his speculations and experiments on the latter subject, that he was led to think of devising some mode of constructing or propelling vessels in circumstances where the ordinary resources of the nautical art were insufficient or unavailing; among these, the construction of double and triple vessels, to be moved by wheels placed in proper situations, had occurred to him as calculated to prove of essential service, and he accordingly built and equipped several vessels of this description.

with the same spirit and perseverance, which had been so conspicuous in many other instances, must for ever be matter of regret to his family, as it was to himself in the latter years of his life." The fact, however, was, "that he had to complain of the enormous expense in which he had been involved; and I may be permitted to add," continues his son, "that by this time my father, in the prosecution of his various schemes of a purely public nature, and without the slightest chance or expectation of reimbursement, had expended upwards of thirty thousand pounds." And, being by this time ardently engaged in agricultural pursuits, his attention was more easily turned from the objects of his former speculations, than those acquainted with his character would have been prepared to anticipate.

"Be that as it may, it cannot be anticipated that in point of fact he had fully established the practicability of propelling vessels of any size, by means of wheels or revolving paddles, and of adapting to these the powers of the steam engine, although, in the subordinate details of execution, great room remained for minor improvements.

"Of my father's peculiar and undoubted merits as an inventor, I have," continues his son, with a pardonable partiality, "endeavored to give a fair and unvarnished account; and of the reality of that invention, as carried into actual practice in the years 1788 and 1789, no demonstration more unequivocal can be desired than that, with his few but most satisfactory experiments, the prosecution of this momentous discovery remained suspended for many years, in a state of inactivity and neglect, till, at a period comparatively recent, it was revived in America, and in this country, by persons who can be proved to have derived their first lights from the experiments at Dalswinton and at Carron. But I have felt no other desire than to record the facts immediately connected with my father's operations, and to establish the priority of his claims to the credit of having originated, and carried into practical execution, an improvement in the nautical art, by far the most important of which the present age has to boast; and the ultimate effects of which, on the future intercourse of mankind, the most sanguine imagination would attempt in vain to predict."

The narrative which Mr. Miller gave of his father's attempt to construct a steamboat, and from which we have made some copious extracts, agrees with an account of the same experiments which was given in a sketch of navigation by steam, inserted in the Supplement to the Encyclopedia Britannica.

Symington, who appears to have been more sanguine than his first patron, of the practicability of navigating vessels by steam, nearly twelve years after his experiments at Dalswinton Loch, found an opportunity to bring his scheme under the notice of a nobleman, who was zealous to encourage projects which had for their object the improvement of inland navigation. Symington, who imagined that a boat moved by wheels could be introduced with great economy, as a substitute for horses, in towing boats on canals, succeeded in inducing Lord Dundas, of Kerse, to assist him to make an experiment, on a great scale, on the Forth and Clyde Canal, with machinery, resembling in its principle that of the Dalswinton model, but modified to suit the purpose which he had more immediately in contemplation.

The result of this application, and the character of his patron, may here be noticed with reference to Symington on another account, besides its connection with a history of his experiment. From an expression in Miller's narrative, that his father was discouraged from proceeding farther from a feeling of disgust at having been involved in unnecessary expenses, an inference might be drawn unfavorable to the memory of an ingenious and worthy man.

But Miller's complaint is, in truth, a very common one; and the estimates even of the most experienced mechanics will probably continue to differ widely from the final outlay, even although those artists have been experimenting on their own means.

"Mr. Miller," says Symington, in his narrative, "being very much engaged in improving his estate in Dumfriesshire, and I also employed in constructing large machinery, for the lead mines at Wanlockhead, the idea of carrying the experiments at that time any further was entirely given up, till meeting with the late Thomas Lord Dundas, of Kerse, who wished that I would construct a steamboat for dragging vessels on the Forth and Clyde Canal, instead of horses. Agreeably to his Lordship's request, a series of experiments, which cost nearly three thousand pounds, were set on foot in 1801, and ending in 1802, upon a larger scale (than those on Dalswinton Loch) and more improved plan, having a steam cylinder twenty-two inches diameter, and four feet stroke, which proved itself very much adapted for the intended purposes. Having previously made various experiments in March, 1802, on the Forth and Clyde Canal, Lord Dundas and several other gentlemen being on board, the steam packet took in tow two loaded vessels, each of seventy tons burden,

and moved with great ease through the canal, a distance of nineteen and a half miles in six hours, although the whole time it blew a strong breeze right a-head of us, so much so, that no other vessels could move to windward in the canal that day but those we had in tow, which put beyond the possibility of a doubt the utility of the scheme in canals and rivers, and ultimately in open seas. Though in this state of forwardness, it was opposed by some narrow-minded proprietors of the canal, under a very mistaken idea that the undulation of the water, occasioned by the motion of the wheel, would wash and injure its banks. In consequence, it was with great reluctance laid up in a creek of the canal, exposed for years to public view, where Henry Bell from Glasgow, who also frequently inspected the steamboat at Carron, in 1789, did also particularly examine this."

During the time that he was engaged in this experiment, Symington received a visit from a Mr. Fulton, "who," says he, "politely made himself known, and candidly told me he was lately from North America, and intended to return thither in a few months; but having heard of our steamboat operations, he could not think of leaving the country without first waiting upon me, in expectation of seeing the boat, and procuring such information regarding it as I might be pleased to communicate. He at the same time mentioned, however advantageous such an invention might be to Great Britain, it would certainly be more so to North America, on account of the many extensive navigable rivers in that country. And as timber of the first quality for building the vessels, as also for fuel to the engines, could be purchased there at a small expense, he was decidedly of opinion it could hardly fail, in a few years, to become very beneficial to trade in that part of the world; and that his carrying the plan to North America could not turn out otherwise than to my advantage, as if I were inclined to do it, both the making and superintending of such vessels would naturally fall upon me, provided my engagements with steamboats at home did not occupy so much of my time, as to prevent me from paying any attention to those which might afterwards be constructed abroad. In compliance with his earnest request, I caused the engine fire to be lighted up, and in a short time thereafter put the steamboat in motion, and carrying him four miles on the canal, returned to the place of starting, to the great astonishment of Fulton and several gentlemen, who at our request came on board. During the above trip, Fulton asked me, 'if I had any objections to his taking notes respecting the steamboat?' to which question, I said 'none;' and after putting several pointed questions respecting the general construction and effect of the machine, which I answered in a most explicit manner, he jotted down, particularly, every thing then described, with his own remarks upon the boat;" "but he seems," says Symington, "to have been altogether forgetful of this, as, notwithstanding his fair promises, I never heard any thing more of him till reading in a newspaper an account of his death."

From these facts, the author of the sketch thinks it is very evident Symington was the first person who had the merit of *successfully* applying the power of the steam engine to the propulsion of vessels, and that there can be but one opinion, that, in its influence on the fate of a most ingenious man, there existed not enterprise enough in Scotland to encourage this excellent artisan to repeat his interesting and important experiments on the river Clyde.

About the time Symington had abandoned his experiments, M. Des Blanc, a watchmaker at Trevoux, had built a steamboat, and made some experiments with it on the river Soane. The first attempts were so successful as to bring forth the Marquis de Jouffroi, with his prior claim; the final result, however, was as hapless as the Marquis's.

Although we insert this statement from an English work, we by no means wish it understood we adopt their opinions. We think otherwise: at all events, our columns are open to all claimants or their friends.

The persevering and ingenious Evans, of Pennsylvania, found that, in an engine working ten saws, when it was put in motion with steam of the elasticity to drive one saw only, and suffer the piston to move briskly, the steam was carried off from the boiler as fast as it was generated, and fuel consumed and time spent to little purpose; but when the steam was confined, and retained in the boiler until it lifts the safety valve with a power sufficient to drive ten saws, it will do that work all day, and consume but little more fuel; and if the working cylinder be eight inches in diameter, it will drive a pair of five feet mill-stones.

This engine, as described, it will be seen, deviates little from the condensing engine of Watt, except in the boiler, the form of which is excellent. One of his first boilers was a cast-iron cylinder, twenty inches in diameter, and twenty feet long, cased on the outside with wood. In other cases, he made the

fire surround the cylinder, and inclosed the flue by brick work.

His boilers were made strong enough by estimation to bear a pressure of 1500 pounds on each square inch, but he generally worked with a pressure of from fifty to one hundred pounds on the square inch. He thought, in comparing the economy of using steam at this high temperature, in an engine without a condenser, with that from 212° to 220° used with a condenser, that, by doubling the fuel, he produced sixteen times the effect. The water was supplied to the boiler by a small forcing pump: he experienced great loss of power, by using cold water as a supply, "for although it lowers the heat but little, yet as it has been shown that a small increase of heat, 30°, doubles the power, so an equal decrease reduces it a half, from one hundred and twenty pounds to sixty pounds' pressure." (p. 37.) Evans therefore used a second or supply boiler, the water of which was heated either by the steam which escaped from the cylinder, or by passing the flue of the furnace under it; as we may suppose that cold water receives heat more freely than hot, he sometimes made his boiler in several parts, passing the flue of the furnace through them all, and forcing the supply of water into that part furthest from the fire, to pass from the one to the other, by small connecting pipes meeting the fire.—[Young Steam Engineer's Guide, p. 49.]

Evans also worked his engines with steam used expansively, and this was probably their most economical application; he raised the temperature of the vapor, to make its elasticity equal to 120 pounds on each square inch, and shut off its entrance into the cylinder when the piston had made a part of its stroke, as practised by Watt and others, with steam of the common temperature. "Thus the piston is driven by strong puffs of steam, the same as an air-gun drives its bullets, with this difference, the air-gun is soon exhausted, but the fire keeps up the power of the steam; the whole power of the steam is expended on the piston before it leaves the cylinder, except what is necessary to resist the atmosphere."

This engine, however, will not bear a comparison with that of Trevithick and Vivian. But the practice of Evans, and his publication on the subject, the first which was professedly of a practical nature, has produced a general impression in favor of using steam of a high temperature in North America; and by thus dispelling the vulgar prejudice which still exists against its use in England, the foundation has been laid for the introduction of improvement, on a principle which is yet thought to be capable of a great and beneficial extension."

Evans, too, had rivals to dispute even his secondary claims to invention. A Mr. John Stevens, of Hoboken, near New-York, had been making experiments to apply steam of a high temperature, by generating it in a boiler formed of small copper tubes, each about one inch in diameter and two feet long, inserted at each end into a brass plate; these plates were closed at each end of the pipes by a strong cap of cast iron or brass, leaving the space of an inch or two between the plates. The necessary supply of water was injected by means of a forcing pump at one end, through a tube inserted at the other end; one of these boilers, six feet long, two feet deep, and four feet wide, exposed four hundred feet of surface in the most advantageous manner to the action of the fire. Stevens said his object was to form a machine adapted more immediately to the propelling of a boat. "He tried a rotary engine, on the axis of which revolved a wheel at the stern of the boat, like a wind-mill or smoke-jack, but he found it impossible to preserve a sufficient degree of tightness in the packing; a second modification of his rotary apparatus, on trial, proved no better than the first. At last he had recourse to Watt's engine, with a cylinder 4½ inches in diameter and a nine inch stroke; the beam was omitted; the boiler, two feet long, fifteen inches wide, twelve inches high, consisted of eighty-one tubes, each an inch in diameter; his boat was twenty-five feet long and five feet wide. This was tried in May, 1804, and had a velocity of four miles an hour; after having made repeated trials with her, his son undertook to cross from Hoboken to New-York, when unfortunately, as the boat nearly reached the wharf, the steam-pipe gave way, having been put on with soft solder. This boiler being damaged, the next one was constructed with the tubes placed vertically. The engine was kept going for a fortnight or three weeks, the boat making excursions of two or three miles up and down the river; for a short distance he could make it sail at a rate of not less than seven or eight miles an hour."*

In the same year, his rival constructed, for the Board of Health in Philadelphia, a machine for cleaning docks. Evans, who was a clever man with a plain name, considering that a sounding cognomen would do no harm to a simple machine, christened his mud-scraper the Orukter Amphibolos. This

* Col. Stevens took out a patent for his boiler in England, in 1805.

was a heavy flat-bottomed boat, thirty feet long, and twelve feet broad, with a chain of buckets to bring up the mud, and hooks to clear away sticks, stones, and other obstacles. A small steam-engine was placed in the boat to work the buckets, having a cylinder five inches in diameter, and a stroke of nineteen inches. "It was constructed one mile and a half from the river Schuylkill; the boat was mounted on wheels, which were moved by the engine; the whole, weighing about 42,000 pounds, was moved with a gentle motion up Market street, in Philadelphia, and around the Centre Square; and he concluded from the experiment, that the engine was able to rise any ascent allowed by law on turnpike roads, which is not more than four degrees; and when the Orukter Amphibolos was launched, he fixed a simple wheel at her stern to propel her through the water by the engine; she drew nineteen inches of water; and he inferred, that is the power had been applied to give the paddle wheel the proper motion, he could have stemmed the tide of the Delaware."

Stevens went no further with his experiment, and Evans also stopped with this exhibition; in discussing their claims, Evans declared that he had spent two thousand dollars on his project; Stevens lamented that he had been "twenty years of his life on his, and spent twenty thousand dollars, without deriving a shilling benefit." Stevens thought some of Evans' projects were absurd: Evans retorted, "that the colonel's setting himself up as an obstacle to his improvements, had done more to perpetuate his (the colonel's) memory than his twenty years' hard work, and the loss of twenty thousand dollars." Be that as it may, although in their lives their schemes were opposed, our respect for their memories shall not be divided, and they shall together enjoy that immortality which our book, we hope, will confer upon them.

This Col. Stevens still is alive, and is respected by all who have the honor of his acquaintance.

We have much pleasure in inserting the following report from Congress:

Steam Boilers.—The select committee of Congress, to whom was referred the memorial of Benjamin Phillips, of Philadelphia, have made the following report:

The object of the memorialist is to invite the attention of Congress, and of the public generally, to certain improvements devised by him in the use and structure of the steam engine. The model of his apparatus, accompanied by drawings and diagrams, illustrative of its principles, have been submitted and examined. Whatever other advantages may be supposed to be combined in the scheme, the committee have considered it chiefly, if not exclusively, in reference to its comparative safety, or exemption from the danger of explosion.

It seems to be a point conceded by scientific observers, that among the primary causes of explosion in steam boilers, one of the most prominent may be traced to the want of a constant and regular supply of water while the engine is in action. The usual means employed, as the committee are advised, both for supplying the consumption of the boiler and for ascertaining the quantum of water in that receptacle, are inadequate and uncertain. The forcing pump is liable to derangement; and when the water has fallen so low as to superinduce the circumstances of danger, neither the common cock, nor the common safety valve, can be relied on for an accurate indication of the state of things so essential to be known. By the plan submitted, these defects appear to be remedied. A constant and uniform supply of water, and a test water gauge, indicating to the eye, at any moment, the precise level of the fluid in the boiler, form a part of the melioration suggested.

But what appears to the committee to be the most distinguished feature of the plan, that it contemplates the employment of the steam at any given pressure, without a corresponding stress on the boiler. This result is obtained by generating the steam at a very moderate pressure on the boiler, from whence it is conveyed for use, to one or more receivers, in which, before it is applied as the momentum to the engine, it may be raised, by flues heated from a separate furnace, to any required degree of elasticity.

The committee are of opinion, that if it be feasible, of which they do not doubt, it must of itself be an important step towards the grand desideratum. Confined in a separate reservoir, not in immediate connection with the boiler, the steam, however rarified, would not be liable to be suddenly injected with water, a process which all concurring experience proclaims to be the proximate cause of many of the most dreadful accidents that have occurred.

The form and position of the contemplated receiver is believed to present another condition of security. Placed vertically on the deck, with chambers or compartments connected by valves, the steam at its greatest tension naturally rushing through the

valves into the upper chambers of the recipient, if ever explosion should take place, it would be a mere effusion of steam, and not of heated water; and the discharge would be upwards, into the open air, leaving untouched the passengers and the property embarked in the vessel.

There are other particulars in the mechanism, of the usefulness of which practical engineers alone are competent to form an accurate estimate. It will suffice to say, that, as a whole, the committee consider the contrivance as reflecting credit on the science and ingenuity of the proprietor, and that his plan is worthy of a full and fair experiment.

On the question as to the power and the expediency of aid and co-operation on the part of government in experiments of this kind, the committee have come to an affirmative conclusion. When it is considered how intimately the subject matter connects itself with the general welfare, looking to the protection of the lives and property of the whole people, that it involves considerations of naval and national defence, as well as the general interests of commerce, it is not thought that any valid opposing argument can be drawn from the want of power, much less can an objection be raised on the score of policy.

The committee have thought proper to recommend a small sum to be placed at the disposal of the Secretary of the Navy, to test the improvements of this branch. It is believed that a reasonable expenditure of the public money for this subject would coincide with the universal sense, and meet the applause of the nation. The knowledge of the mode of controlling and directing with safety this powerful, but hitherto dangerous, agent in the affairs of men, would be cheaply purchased at the cost of millions.

We most sincerely hope that the provisions of the following law may be enacted in every State in the Union—it would, we think, be an effectual check to the careless manner in which some of our steam engines are looked after.

Steamboat Law.—Louisiana has been the first state to set the example of vigorous legislation for the prevention and punishment of negligence in the navigation and management of steamboats. For the synopsis of the law which she has made on that subject, we are indebted to the Baltimore American, as follows:—[Nat. Intel.]

The Legislature of Louisiana, which has just adjourned, adopted a very severe, and, we trust, efficient law, for the regulation of steamboats, so as to secure them from explosion. The number of fatal accidents on the Mississippi, particularly the disastrous one by which Senator Johnston lost his life, imperiously called for some legislative interference, to secure care and fidelity in the management of engines, and every practical assurance of their soundness. The new law manifests great anxiety to establish minute precautions against accident, as well as misconduct; and imposes heavy penalties on the agents and owners in every case of damage which any possible care might have prevented. To make the law more effective, it has been sent to the Executives of all the States bordering on the Mississippi, and its tributaries, for similar action.

The law establishes the office of State Engineer for the port of New-Orleans. The duty of the Engineer is to examine once in three months the strength of the boilers of steamboats plying within the waters of the state; to test them by hydraulic pressure to *three* times the weight of steam they may be supposed capable of carrying; and to furnish each boat with a certificate, specifying the weight of steam which may be safely used.

In case any accident happens on board of any boat not possessing the proper certificates, neither captain, owner, or agent, can recover any claim for freight or insurance; the owner or agent is made responsible to the shipper, to the full amount of all damage; and the captain is further subjected to a fine, not less than $500, nor more than $2000, and to imprisonment for not less than three months, nor more than three years. If lives are lost, the captain is to be adjudged guilty of manslaughter. The same penalties to the several parties are provided in case of any accident in navigation, from overloading, racing, carrying higher steam than the certificate allows, or any accident "that may occur while the captain, pilot, or engineer, is engaged in gambling, or attending to any game of chance or hazard."

The same penalties are provided in case of any accident from gunpowder, shipped without a written notice of the fact being posted in three conspicuous parts of the boat.

Shippers are made liable to a fine of two hundred dollars for shipping gunpowder, without notice to the master's clerk; and also made liable for damages that may happen by any accident therefrom; and in case of loss of life, are adjudged guilty of manslaughter.

In passing, on the river, the descending boat is commanded to shut off steam and float down, when within a mile of an ascending boat—the latter to assume the responsibility of steering clear of the other, and being liable for all damages.

Other minute directions are given, but the above form the principal enactments of the law, which appear to be drawn up with a determination to enforce rigorous penalties against any carelessness in the management of steam engines on the Mississippi, within the limits of the State of Louisiana.

It is known that we have been much censured on this subject. The following is from a London paper:

Brother Jonathan at Fault.—The Americans either cannot or will not make their steam-boilers so secure as the English; a fact proved by the accounts in the United States' papers of twelve fatal steamboat accidents in the short space of six weeks, and the recommendation by the President of a new law upon the subject. This must surely be a puzzling fact for those sneerers at "over legislation," who maintain that the public are quite able and quite willing to take sufficient care of themselves in such matters, without the *officious interference* of parliaments.

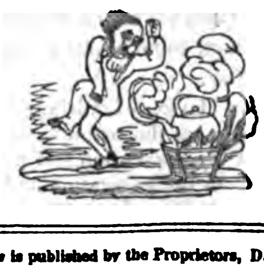
Mr. Bethune's Steamer.—We have examined the model of the boat now placed at the Exchange. It resembles, in the build of its hull, Mr. Burden's boat: but instead of two barrels, it has *three*, and the wheels revolve on each side of the middle barrel. The draft of water is very little, and undoubtedly the speed of the boat would be great. It has also some advantages over the other boats, in the arrangements above deck, offering a covered walk of 412 feet, &c. Upon the whole, Mr. Bethune's exertions deserve encouragement, and may lead to some real improvements. With the present overdone business in steamers, and the general depression of trade, it could hardly be expected that large investments would be made in a new scheme of this kind. What we want most, and what might afford some prospect of success, would be small boats, built as cheaply as possible, *for passengers alone*, and having great speed. Such improved boats run in several parts of Great Britain, and particularly on the Clyde in Scotland. Under present circumstances, such a speculation would also be very uncertain. But ultimately, our *freight and passage* steamers must be replaced by those for passage only; without, indeed, railroads take the place of all descriptions of water carriage, the latter being certainly less rapid and more expensive.

We copy Mr. Bethune's own statement of the dimensions and properties of his model:

Dimensions of the Model.—(Scale, ¼ inch to a foot.)—Centre tube, length 220 feet, side tubes, ed. 190, diameter 12 feet ed. at centre, and 2 feet at the ends; extreme length on deck, 244 feet; extreme breadth in centre, 72 feet; lower cabin, length 192 feet, centre breadth of the same 52, stern breadth 37; upper cabin, length 182, centre breadth 40, stern do. 29; height of both cabins, 7½ feet; lower wings on deck, 10 feet, outside of cabin; fender outside of tubes, 5 feet on each side; upper piazza, breadth 8 feet, circumference or length of walk round which is 412 feet; promenade deck, length 194 feet; spaces between the tubes, 13 feet; proposed diameter of two water wheels, 27 feet; total weight of the three tubes, superstructure, and two engines of 50 horse power each, on board, 275½ tons, which will displace 9875 cubic feet of water. Draught of water, when light, 3 feet 9 inches; do. with 1500 passengers on board, 4 feet 6 inches. Cargo required to sink the tubes to their centre, or to six feet draught of water, 336 tons.—[Quebec Gazette.]

Steam-digging Machine.—M. Wronski, a celebrated mathematician at Paris, has, according to the Paris papers, discovered a new system of applying steam to carriages, digging machines, hoes, picks, ploughs, &c. so superior to any thing hitherto known, that a French company has bought his patent for four millions of francs.—[Le Temps.]

Numerous have been the conjectures respecting the first discovery of the power of steam. It is a question which we cannot decide; but an ingenious friend handed us the annexed engraving, accompanying it with his opinion, *after much research*, that it represents the first impression ever made on the human frame by steam. We insert it, and for this week must conclude.



The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*.—John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS,

Volume III.] FOR THE WEEK ENDING JUNE 21, 1834. [Number 6.

" Soon shall thy arm, unconquered steam! afar
Drag the slow barge, or drive the rapid car;
Or, on wide waving wings, expanded, bear
The flying chariots through the fields of air."—Darwin.

FAIRMAN'S ROTARY STEAM ENGINE.

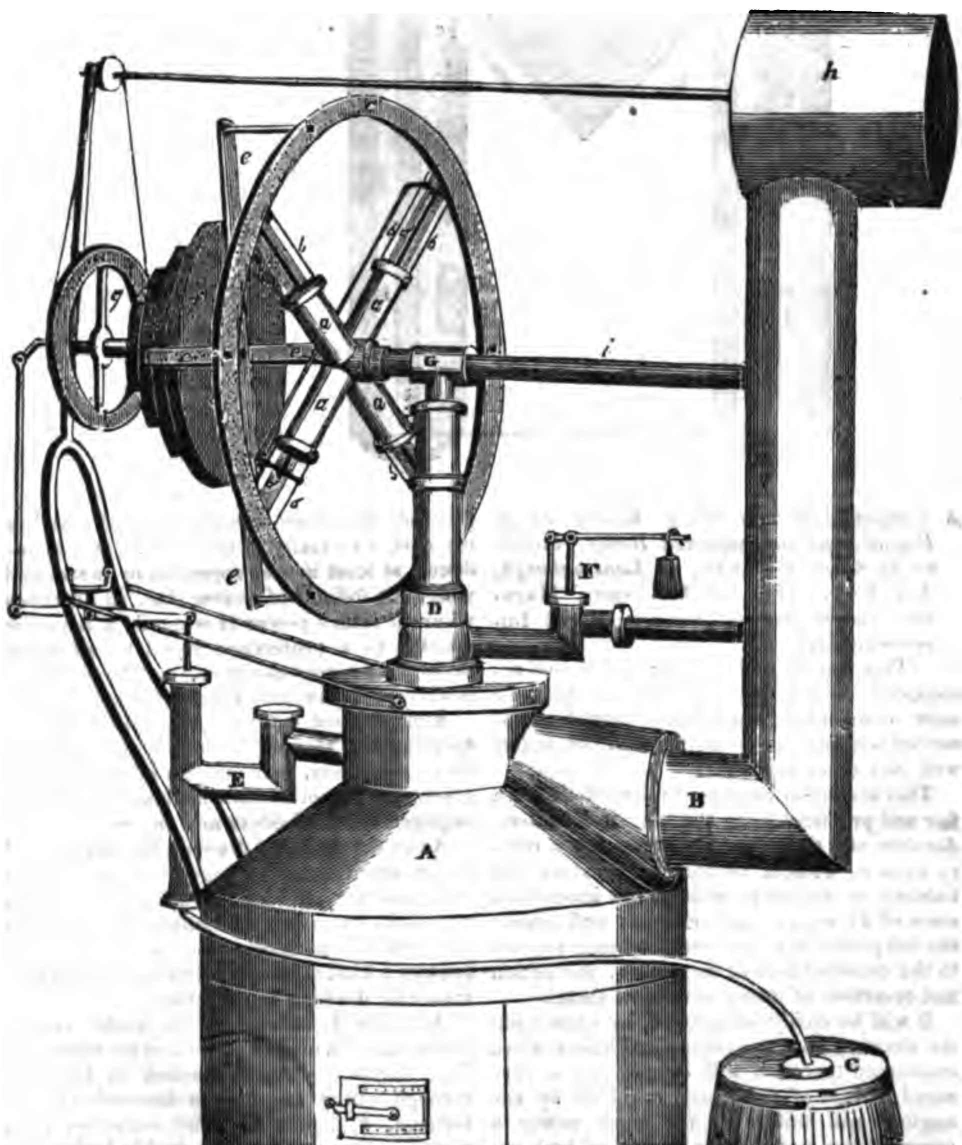
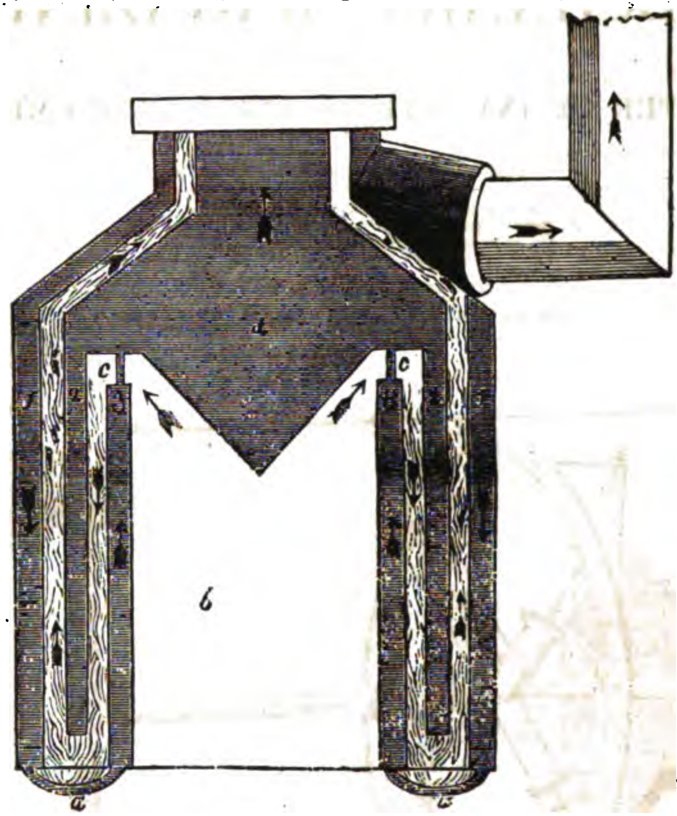


Fig. 2.



A Compound Reciprocating Rotary Steam Engine, and an Improved Boiler, *invented by* SIMON FAIRMAN, *of Lansingburgh, New-York.* [For the Mechanics' Magazine and Register of Inventions and Improvements.]

This engine and boiler may be used separately, or the two together, as may be most convenient; the engine may be connected with any other boiler, and the boiler with any other engine.

This invention presents to the public, in a fair and practical form, the long-sought *desideratum* of a steam engine producing a rotary motion, without undue complication and liability to disorder; without the inconvenience of fly wheels and cranks; and giving the full power of steam without being subject to the constant loss of impetus by the action and re-action of heavy masses of metal.

It will be easily discovered, by examining the drawing, that this engine and boiler, when connected together, will occupy but a very small portion of the space required by the engines and boilers of the same power in common use, and that the weight of both engine and boiler are equally reduced; and as the cost, especially of the engine, is also reduced, at least in the proportion to its size and weight, it follows of course that, in all cases where a rotary power is wanted, it must be entitled to a preference equal to all those savings and conveniences, and for all locomotive purposes, still much greater.

And it must be no less obvious, on inspecting the plan of the boiler, that, besides its compactness, it is capable of producing a given quantity of steam with less fuel than is required for the boilers now in use.

As in the annexed drawing the engine and boiler are connected together; and, as to communicate an idea of the boiler, it was necessary to give a sectional view, showing the form of the inside, the description will require a kind of mixed reference alternately from one drawing to the other.

A, figure 1, represents the boiler entire, the inside of which is explained by figure 2. The furnace door is shown in figure 1, through which the fuel is inserted into the furnace, *b*, figure 2. The water is contained in three concentric double hollow cy-

linders, numbered in figure 1,—1, 2, 3. It is received from the supply pump, E, figure 1, into the outer cylinder, No. 1, and passes thence through bent tubes, *a, a,* into the inner cylinder, No. 3, which forms the furnace, from which it passes through the tubes, *c, c,* figure 2, into the centre pan at the top, *d,* which pan is connected with the middle cylinder, No. 2, from which enclosure and pan it goes through the upright or main conductor, D, figure 1, to the engine.

The fire goes from the furnace, *b,* and the top of the inner cylinder, thence down between that and No. 2, and, passing under No. 2, goes up between that and No. 1, and out through the small pipe, B, figure 1; and, when necessary, the draught is accelerated by a blower in the cylinder, *n.* The bottom of the furnace has a grate and ash pan, which need no description.

The spaces between the double cylinders, and in the centre pan, in which the water and steam are contained, are shaded in the sectional view, and the furnace and spars between the cylinders through which the fire passes are left white.

C, figure 1, represents the water tank; F, the safety valve; G, the horizontal pipe forming part of axis, through which the steam is conducted to and from the engine.

a, a, a, a, are four cylinders, in all respects similar to those of the common reciprocating steam engine; which cylinders stand at right angles with each other, with their bottoms resting upon a cylindrical hub, or centre; the cylinders of course forming a cross.

b, b, &c. are the slide rods, part of which only are seen. The bottoms of the slide rods are attached to the flanges round the tops of the cylinders, and their tops to a rim of cast iron, *c,* which rim also steadies and supports the tops of the cylinders by four straps, or parts of arms, *d, d, d, d,* which are bolted to the tops of the cylinders.

e, e, e, e, are four arms, connected with said rim by studs of sufficient length to leave room between said arms and the cylinders for the connecting rods to revolve, and to which arms is attached the main or driving pulley, *f,* or in place thereof a cog-wheel, as the case may require.

The connecting rods and cross-heads being mostly hid in the representation, are so nearly in the common form as to need no description. But the feet of the said connecting rods are connected together by a moveable joint, so as to revolve round a centre-pin, which is removed from the centre round which the cylinders revolve, just half the length of the stroke of the pistons.

The steam is conducted through a hole lengthwise in the main axis G, and out through a hole in the side thereof into the bottom of each cylinder successively, as they revolve.

On the side of each cylinder is a tube, passing from the bottom to the top, and also connected at the bottom with that which lets the steam into the bottom of the opposite cylinder, so that when the steam is let into the bottom of one cylinder it enters the top of the one opposite; and as the feet of the connecting rods revolve round a centre at some distance from the centre of the main axis, as the pistons act and re-act, the cylinders must of course revolve round the axis; and when each cylinder has passed round to the opposite side from whence it filled, the steam escapes through a hole on the opposite side of the axis into a hole lengthwise of the axis, and parallel to the one by which it entered, and goes off through the discharge pipe *i.*

Mr. F. will engage to construct an engine and boiler of fifty horse power, of strong and permanent workmanship, which (both engine and boiler) shall stand on a circle of six feet diameter, and will not vary much in weight from three tons. And operating with a steady rotary impulse and without any jar, its operation will be much pleasanter in steamboats, and also prevent the injury done to the boats by the constant racking motion of the engines now in use.

This engine and boiler will be in operation in a few days at 246 Water street, New-York.

Since the above was in type, we have received the following from Mr. Fairman:

To the Editor of the Mechanics' Magazine:

SIR,—However I may be reduced, by the misfortune, or rather the folly, of having undertaken to invent useful mechanical improvements, my pride is not so far overcome as to be willing to ask any services on the score of charity; but if, from any other motive, you should see fit to give this a place in your Magazine, I wish you better remuneration for so doing than to meet the fate of an inventor.

I had long been led to believe that a *rotary* steam engine, simple, operative, and sure in its construction, with an efficient boiler, both so compact, and consequently light, as not to overburthen their own power, and peculiarly adapted to locomotive purposes, was a desideratum for which the enlightened public would liberally reward the inventor, if such an inventor could be found. I had good authority for so believing. Many respectable writers on the subject of steam

power, have noticed the importance of such an invention, but all I have seen have considered it impracticable.

Mr. Nicholson, in his Operative Mechanic, (Philadelphia edition, page 206,) says: "All steam engines, as yet noticed, have their action by the movement of a piston, in a cylinder, and act by what is called a reciprocating motion. In engines of this description a very considerable degree of power is expended in arresting the motion of the different working parts, and putting them into action in a contrary course. This has claimed much attention of engineers, and many attempts have been made to construct an engine in which the action of the steam should operate in a continuous manner, without bringing the parts to a state of rest."

Again he remarks, (page 213,) "The reciprocating motion in steam engines is a loss of power, which cannot be denied, for the momentum of the beam and other parts, passing in one direction, have suddenly to be arrested and moved in the opposite direction, which produces a loss of power.

"Rotary action has been sought, therefore, with propriety, but has not yet been attained with advantage."

Since Mr. Nicholson wrote the foregoing, the importance of locomotive steam powers has nearly doubled, and yet I have known of no attempt which was likely to succeed in effecting the desired object.

With these views of the subject, and believing, or at least hoping, it was practicable, I undertook, and have no hesitation in stating, that I have effected all that the subject required. I have constructed an engine and boiler as little liable to disorder, and as easily kept in repair, as any other, and, I believe, with at least double the power, in proportion both to the cost and weight, of any which has come to my knowledge.

But my want of pecuniary means compelled me to let the engine and boiler which formed the first experiment, and which could not be expected to be perfect, go out of my control, and be placed where, by awkward management, if it be not condemned, it will discredit rather than benefit the invention. No man of judgment would expect perfection in a first experiment; but fortunately there was no mistake perceived in the engine, and but for a slight miscalculation in the boiler, I would not wish my reputation to stand, as an inventor, on a better foundation.

I cannot now invest the necessary sum in materials to exhibit my invention to the public, but if any gentleman or company interested in procuring the best locomotive engine and boiler, after due examination of my plan, will furnish materials, I will hazard all the labor of constructing them at short notice, and will guarantee, as far as my labor goes, that they shall not vary essentially from the following calculations:

A boiler, which shall expose 160 feet of heating surface to the water, and shall possess sufficient strength to work steam under 100 lbs. pressure to the inch above the atmosphere, and which, of course, must produce a sufficiency of steam for a fifteen or sixteen horse power; an engine with 4 cylinders, 6 inches diameter, 18 inch stroke, making four double strokes at each revolution, and 50 to 60 revolutions per minute, working off from 78 to 94 feet of steam.

The whole engine, boiler and furnace, shall only occupy a circular space of three feet six inches diameter; and shall weigh less than a ton. A boiler and furnace sufficient for a fifty horse power shall stand on a circle six feet in diameter.

All which facts are respectfully submitted by the public's humble servant,

SIMON FAIRMAN.

P. S.—I have no wish nor reason to find any fault with the conduct of the gentleman in whose hands my steam engine is placed in New-York. I have found nothing ungentlemanly or unfair in his conduct. The only difficulty is, the engine was taken away prematurely. S. F.

History of Chemistry. [Concluded from page 279.]

OF BISMUTH.—Bismuth is of a reddish white color, and almost destitute both of taste and smell. It is composed of broad brilliant plates adhering to each other. The figure of its particles, according to Hauy, is an octahedron, or two four-sided pyramids, applied base to base.

Its specific gravity is 9·822; but when hammered cautiously, its density, as Muschenbroeck ascertained, is considerably increased. It is not, therefore, very brittle; it breaks, however, when struck smartly by a hammer, and consequently is not malleable. Neither can it be drawn out into wire. Its tenacity, from the trials of Muschenbroeck, appears to be such, that a rod one tenth of an inch in diameter is capable of sustaining a weight of nearly 29 lbs.

When heated to the temperature of 476° it melts; and if the heat be much increased it evaporates, and may be distilled over in close vessels. When allowed to cool slowly, and when the liquid metal is withdrawn, as soon as the surface congeals, it crystallizes in parallelopipeds, which cross each other at right angles.

When exposed to the air it soon loses its lustre, but scarcely undergoes any other change. It is not altered when kept under water.

Bismuth is alloyed with several metals, in order to give them hardness, rigidity, or consistence; it is particularly useful to the pewterers, and all those who employ white and hard alloys. It is generally believed that it acts upon the animal economy in the same manner as lead, though this opinion is yet supported by no decisive facts.

The utility of its oxides is very considerable. It is employed in this form by the manufacturers of porcelain in the preparation of some yellow enamels; it is mixed with other oxides, in order to tinge the color of glazes and paintings. It is sometimes used in the manufacture of colored glass, and to give a yellow tinge approaching to green. The white paint or focus made from the oxide of bismuth is often used by females to paint the face; but it injures the skin very much, and is converted to a black by sulphuretted hydrogen gas.

Of Antimony.—Antimony is of a greyish white color, and has a good deal of brilliancy. Its texture is laminated, and exhibits plates crossing each other in every direction, and sometimes assuming the appearance of imperfect crystals. Hauy has with great labor ascertained that the primitive form of these crystals is an octahedron, and that the integrant particles of antimony have the figure of tetrahedrons.

When rubbed upon the fingers, it communicates to them a peculiar taste and smell.

Its specific gravity is, according to Brisson, 6·702; according to Bergman, 6·86. Hatchett found it 6·712.

It is very brittle, and may be easily reduced in a mortar to a fine powder. Its tenacity, from the experiments of Muschenbroeck, appears to be such, that a rod of one tenth of an inch in diameter is capable of supporting about 10 pounds weight.

When heated to 810° Fahrenheit, or just to redness, it melts. If after this the heat be increased, the metal evaporates.

Antimony is the base of the alloy which is employed for casting printing types, to which it communicates hardness. It is often made to enter, with lead and tin, into rigid hard alloys, which are very useful for a variety of purposes. The oxide of antimony is used in the fabrication of colored glass, enamels, the glazing and painting upon porcelain; it is the basis of the yellow, brownish, and orange colors, which resemble the amethyst. It is mixed with several other oxides in order to produce a great variety of colors, the effects of which have been observed, but their causes have not yet been explained.

Of Manganese.—Manganese is distinguished from all other metals by the following properties. It is of a brilliant whiteness, approaching to grey, which is quickly altered in the air; its texture is granulated, without being so fine and close as that of cobalt; its fracture is rough and unequal; its specific gravity is 6·850; it holds, together with iron, the first rank in the order of hardness; it is one of the most brittle metals; at the same time it is one of the most difficult to be fused. Guyton places it immediately after platina, and determines it at the 160th degree of Wedgwood's pyrometer. We know neither its dilatability by caloric, nor its conducting property. It is frequently susceptible of being attracted by the loadstone, especially when it is in a state of powder, on account of the iron which it contains, and which is almost as difficult to be separated from it as from nickel; it has no perceptible smell nor taste; in communication with other metals, it exerts the galvanic action upon the nervous and muscular systems of animals; its color is extremely variable.

Only one ore of manganese is as yet well known, namely, its native oxide, which some modern mineralogists, amongst others Mr. Kirwan, announced as being combined with carbonic acid. This oxide is frequently mixed with iron, barytes, silex, lime, &c.; it varies also by its state of oxidation, or by the proportion of oxygen which it contains.

The ores of manganese are not worked in the large way, not merely on account of the refractory nature of these ores, but more especially because it is of no utility in its metallic state. The places where the native oxide of manganese is found are merely worked in order to furnish the manufactories of glass, bleaching, &c. with this oxide, which is employed in them.

Of Cobalt.—The ores of cobalt have been used in different parts of Europe since the beginning of the 16th century, to tinge glass of a blue color. But the nature of cobalt was altogether unknown till it was examined by Brandt, in 1733. This celebrated Swedish chemist obtained from it a new metal, to which he gave the name of cobalt. Lehmann published a very full account of every thing relating to this metal in 1761.

Cobalt is of a grey color, with a shade of red, and by no means brilliant. Its texture varies according to the heat employed in fusing it. Sometimes it is composed of plates, sometimes of grains, and sometimes

of small fibres adhering to each other. It has scarcely any taste or smell.

Its specific gravity, according to Bergman, and the School of Mines at Paris, is 7·7. Mr. Hatchet found a specimen of 7·645.

It is brittle, and easily reduced to powder; but, if we believe Leonhardi, it is somewhat malleable when red hot. Its tenacity is unknown. When heated to the temperature of 130° Wedgwood, it melts, but no heat which we can produce is sufficient to cause it to evaporate. When cooled slowly in a crucible, if the vessel be inclined the moment the surface of the metal congeals, it may be obtained crystallized in irregular prisms.

Like iron, it is attracted by the magnet; and, from the experiments of Wenzel, it appears that it may be converted into a magnet precisely similar in its properties to the common magnetic needle.

Cobalt is not used in its metallic form; but it is much employed to make blue glasses or enamels. In the manufactories of porcelain, much care is taken to have the oxides of cobalt very pure and attenuated. The grey ore is chosen well crystallized; this is roasted, and treated with the nitric or muriatic acid, or otherwise it is burned with nitrate of potash; the oxide is carefully washed with much water, by which treatment the oxide is obtained in violet-colored powder, very fine, and very homogeneous, which affords the purest and most beautiful blue when treated with a vitreous flux. The elegant blue of the porcelain of Sevres is of this nature.

Of Tellurium.—In the year 1797, Mr. Klaproth, of Berlin, discovered a brittle whitish metal among the ores of gold brought from the mountains of Transylvania, to which he gave the name of *Tellurium*.

Pure tellurium is of a tin-white color, verging to lead-grey, with a high metallic lustre, of a foliated fracture, and very brittle, so as to be easily pulverized. Its specific gravity is 6·115; it melts before ignition, requiring a little higher heat than lead, and less than antimony; and according to Gmelin, is as volatile as arsenic. When cooled without agitation, its surface has a crystallized appearance. Before the blow-pipe on charcoal, it burns with a vivid blue light, greenish on the edges, and is dissipated in greyish white vapors of a pungent smell, which condense into a white oxide. This oxide, heated on charcoal, is reduced with a kind of explosion, and soon again volatilized. Heated in a glass retort, it fuses into a straw-colored striated mass. It appears to contain about 16 per cent. of oxygen.

Nothing decisive can yet be said concerning the uses of this metal, on account of its scarcity and its recent discovery. But should it be found in other ores, as well as in those of Transylvania, it may become of great utility in the arts, as appears from its extreme fusibility, and its slight adhesion to oxygen.

Of Arsenic.—From the earliest period in which mankind worked the metallic ores, they must have ascertained the volatility, the odor, and the obnoxious effects of arsenic. Nevertheless, it remained unknown as a metal, and was not placed among the semi-metals, or brittle metallic bodies, till the beginning of the 18th century, when Paracelsus announced that it might be obtained white in the metallic form. Schroeder, in 1649, mentioned a metal extracted from orpiment and arsenic; and Lemery, in 1675, described a process which is at present used with success in the mixture of fixed alkali and soap with this oxide, to obtain what is called the regulus. The ancients were acquainted with its oxide, its yellow and red sulphuret, under the name of arsenic, sandarach, and orpiment. Mineralogists were for a long time content to range it among sulphureous matters, and considered it only as a mineralizer of the metals. Brandt, in 1733, and Macquer, in 1746, showed that it is a true metal, possessing properties highly characteristic, and different from those of every other metal.

Arsenic has a bluish white color, not unlike that of steel, and a good deal of brilliancy. It has no sensible smell while cold; but when heated, it emits a strong odor of garlic, which is very characteristic.

Its specific gravity is 8·31.

It is perhaps the most brittle of all the metals, falling to pieces under a very moderate blow of a hammer, and admitting of being easily reduced to a very fine powder in a mortar.

Its fusing point is not known, because it is the most volatile of the metals, subliming without melting when exposed in close vessels to a heat of 356°.

Arsenic, in the metallic form, is but little employed, except in chemical laboratories, where various experiments, researches, and demonstrations are carried on.

As it is sometimes employed for killing flies, great caution should be used in applying it to this purpose; for this substance, which is sold under the name of testaceous cobalt, or fly powder, is very dangerous to animals of every description.

In some manufactories it is alloyed with various metals, in order to whiten and harden

them; the white copper is frequently an alloy of this kind. But though such alloys may be of use in some cases, they ought never to be employed for the preparation of food, drinks, or medicines.

OF CHROMIUM.—The analysis of a mineral made by other means, and with more care than hitherto had been applied to its examination, presented in December, 1797, to Vauquelin, the discovery of this metal. It is of a white color, inclining to grey, very hard, brittle, and extremely difficult of fusion. The small quantity which Vauquelin could procure did not permit him to ascertain many of its properties. It is but little altered by exposure to heat, and probably would be affected neither by the action of air nor of water. Acids act upon it but slowly; nitric acid gradually converts it into an oxide by communicating oxygen.

It is hardly to be supposed that a metal so recently discovered can have yet been applied to any use. However, Vauquelin has already observed that its oxide may be used in the fabrication of glass and enamel; and it may even, perhaps, have been already employed, without suspecting it, in the mixtures of the products of minerals ill understood or analyzed, of which it may form a part.

OF MOLYBDENUM.—The name of molybdena, which was formerly synonymous with that of plumbago, or black lead, or the natural combination of iron and charcoal, or carburet of iron, is at present given to a brittle and acidifiable metal, of which the ore was confounded with that coally substance. Many considered them as one and the same substance, and they were sold under the same denomination, till Scheele, in 1778, published in the volumes of the Stockholm Academy a memoir, in which he showed that the substance called molybdena is very different from the carburet of iron, and contains a combination of sulphur, with a substance which he took for a peculiar acid.

Hitherto molybdenum has only been obtained in small agglutinated metallic grains; the greatest heat of our furnaces not being sufficient to melt it into a button. Hence we are but imperfectly acquainted with its properties.

The specimens produced by Hielm were of a yellowish white color, and internally greenish white.

Its specific gravity he found as high as 7·400. From his experiments, compared with those of Klaproth and Buckolz, on uranium, it seems probable that molybdenum is even more refractory than that metal.

When exposed to heat in an open vessel, it gradually combines with oxygen, and is converted into a white oxide, which is volatilized in small brilliant needle-form crystals. This oxide having the properties of an acid, is known by the name of *molybdic acid.*

OF TUNGSTEN.—The name Tungsten, which signifies heavy stone, was given by the Swedes to a mineral which Scheele found to contain a peculiar metal, as he supposed, in the state of an acid, united with lime. The same metallic substance was afterwards found by Don d'Elhuyart, united with iron and manganese in wolfram.

Tungsten is of a greyish white color, or rather like that of iron, and has a good deal of brilliancy.

It is one of the hardest of the metals; for Vauquelin and Hecht could scarcely make any impression upon it with a file. It seems also to be brittle. Its specific gravity, according to the d'Elhuyarts, is 17·6; according to Allen and Aiken, 17·22. It is therefore the heaviest of the metals after gold and platinum.

It requires for fusion a temperature at least equal to 170° Wedgwood. It seems to have the property of crystallizing on cooling, like all the other metals; for the imperfect button procured by Vauquelin and Hecht contained a great number of small crystals.

Nothing has yet been observed respecting the uses of a metal so little known or examined as tungsten. No trial has yet been made with regard to its useful properties; and it is to be feared, that its reduction and fusion being difficult, will render it so intractable as not to be used but with great difficulty.

OF COLUMBIUM.—This metal was discovered by Mr. Hatchett, in a mineral belonging to the cabinet of the British Museum, supposed to be brought from Massachusetts, in North America.

Its lustre was glassy, and in some parts slightly metallic. It was moderately hard, but very brittle. By trituration it yielded a powder of a dark chocolate brown, not attracted by the magnet. Its specific gravity, at the temperature of 65°, was 5·918.

OF SELENIUM.—In 1819, M. Berzelius extracted a new elementary body from the pyrites Fahlun, which, from its chemical properties, he places between sulphur and tellurium, though it has more properties in common with the former than with the latter substance. It was obtained in exceedingly small quantity from a large portion of pyrites.

When it is fused it becomes solid, its surface assumes a metallic brilliancy of a deep

brown color. Its fracture is conchoidal, vitreous, of the color of lead, and perfectly metallic.

Of Osmium.—This singular metal was discovered by Mr. Tennant, about the year 1804, in the ore of platina, combined with another metallic substance, which received the name of Iridium.

Osmium has a dark grey or blue color, and the metallic lustre. When heated in the open air it evaporates with the usual smell; but in close vessels, when the oxidizement is prevented, it does not appear in the least volatile. When subjected to a strong white heat in a charcoal crucible, it does not melt nor undergo any apparent alteration. It is not acted upon by any acid, not even the nitro-muriatic, after exposure to heat; but when heated with potash, it combines with that alkali, and forms with it an orange yellow solution.

Of Rhodium.—This metal is of a white color. Its specific gravity seems somewhat to exceed 11. No degree of heat hitherto applied is capable of fusing it. It is, therefore, uncertain whether it be malleable; but as it forms malleable alloys with the other metals, it is probable that it would not be destitute of malleability, if it could be fused into a button.

Of Iridium.—This metal was discovered by Mr. Smithson Tennant in 1803, in the ore of crude platina.

The iridium which was thus obtained was white, and could not be melted by any heat Mr. Tennant could employ. Vauquelin considers it as brittle, and as even occasioning the brittleness of platinum; but as it has not been obtained in a metallic button, and as it forms malleable alloys with all metals tried, that property does not seem to be sufficiently decided. It resists the action of all acids, even the nitro-muriatic acid.

Of Uranium.—This metal was discovered by Klaproth in a mineral which contains uranium combined with sulphur.

By treating the ores of the metal with the nitric or nitro-muriatic acid, the oxide will be dissolved, and may be precipitated by the addition of a caustic alkali. It is insoluble in water, and of a yellow color; but a strong heat renders it of a brownish grey.

Of Titanium.—Titanium is obtained from a mineral found in Hungary, called red schorl, or titanite; and also in a substance from the valley of Menachan, in Cornwall, termed menachanite. It was in the latter substance that it was originally discovered by Mr. Gregor, of Cornwall; and its characters have since been more fully investigated by Klaproth, Vauquelin, Hecht, Lowitz, and Lampadius.

Its color is that of copper, but deeper. It has considerable lustre. It is brittle, but in thin plates has considerable elasticity. It is highly infusible.

When exposed to the air it tarnishes, and is easily oxidized by heat, assuming a blue color. It detonates when thrown into red hot nitre.

Of Cerium.—Cerium was discovered by Messrs. Berzelius and Hisenger, of Stockholm, in a mineral from Bastraes, in Sweden, to which they gave the name of Cerit, and which had been for some time before supposed to be an ore of tungsten. This discovery has since been confirmed by the experiments of Vauquelin.

Of Wodanium.—This is a new metal, recently discovered by Lampadius in the mineral called *Wooden Pyrites*. This metal has a bronze-yellow color, similar to that of cobalt glance, and its specific gravity is 11·470. It is malleable; its fracture is hackly; it has the hardness of fluor spar; and is strongly attracted by the magnet.

It is not tarnished by exposure to the atmosphere at the common temperature; but when heated, it is converted into a black oxide.

Alkaline and Earthy Metals.—The remaining substances contained in the table of metal, at page 97, are the bases of the two fixed alkalies, (potash and soda,) and of the eleven substances at present considered as earths.

The two first, potassium and sodium, as well as barium, and a few of the others, were obtained by Sir H. Davy, by decomposing the alkalies and earths by galvanic electricity; whilst the others are *merely* considered as the metallic bases of the respective earths whose names they bear.

Animal Mechanics, or Proofs of Design in the Animal Frame. Part II., showing the Application of the Living Forces. [From the Library of Useful Knowledge.]

(Continued from page 337.)

Here we find a very beautiful muscular apparatus which is necessary to the perfect adjustment of these cords. The cords are attached to small muscles called *columnæ carneæ*, C C, or fleshy columns, which at their other extremities are incorporated with the muscular wall of the ventricle itself. The use of these muscles is now to be explained. Had the tendinous cords of the valves been tied to the inside of the wall of the ventricle, without the intervention of these muscles, as the walls of the cavity approach each other during their con-

traction, the tendinous cords would have been let loose, and the margins of the valves carried back into the auricle. But, by the intervention of these muscles, they are pulled upon and shortened in proportion as the sides of the cavity approach each other.

On the whole, then, we perceive that this apparatus, which is as intricate as the rigging of a ship, consists of a variety of fleshy columns and cords, many of which, in fact, run across the cavity of the ventricle.

We are about to exhibit another form of a valve, much simpler, and yet we are bound to believe equally effectual; which tends to support the opinion expressed above, that besides preventing the retrograde motion of the blood, this intricate apparatus of the ventricle is intended more effectually to agitate and to mix the different streams.

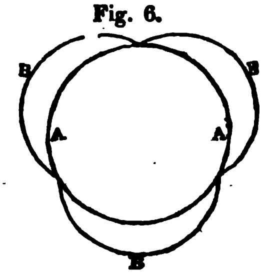
At the root or origin of the great artery, called the *Aorta*, there is a firm ring, to which the valves now to be described are attached. The necessity of this will appear evident, since, if the ring could be stretched by the force of the heart's action, the valves or flood-gates would not be sufficient to close the passage; their conjoined diameters would not equal that of the artery which they have to close. These valves are three in number: they are little half-moon shaped bags of thin membrane, which are thrown up by the blood passing out from the ventricle, but by the slightest retrograde movement of the blood, their margins are caught, and then, being distended or bagged, they fall together and close the passage. There are some curious little adjuncts to these valves, which ought to be explained, as shewing the accuracy of the mechanical provision.

When the margin of the valve is thrown up by the blood passing out of the heart, it is not permitted to touch or fall flat upon the

Fig. 5.

side of the artery, for, if it did, it would not be readily caught up by the blood that flows back; there is, therefore, a little dilatation of the coats of the artery behind each valve, by which, although the margins of the valve be distended to the full circle, they never cling to the coats. These valves, then, are never permitted to fall against the coats of the artery, and therefore they are always prepared to receive the motion of the refluent blood.

Fig. 6.



Let this figure represent a transverse section of the root of the aorta: A A, the inner circle, is the margin of the three valves thrown up to let the blood pass. B B B are three semi-circular bags, formed by the dilatation of the coats of the artery at this part, receding from the margin of each of the valves—consequently, in such a manner as to leave a space between the valves and the sides of the vessel.

To strengthen the valves, a tendon runs along their margin, like the bolt-rope or foot-rope along the edge of a sail, and these ligaments are attached to the side of the artery, and give the valve great strength.

Fig. 7

These valves, we have said, are semilunar, consequently, when they fall together there must be a space, A, left between them. If we put the points of the thumb, fore and middle fingers, together, there is a triangular space left between them; such a space between the convexities of the three valves would be a defect.

Fig. 8.

This figure represents the artery open, and the semi-circular valves, like little bags, attached to the inside.

Three little bodies like tongues are therefore attached to the middle of the margin of each valve, and these, falling together when the valve is shut down, perfect the septum and prevent a drop of blood passing backwards.

---

*Effect of Combinations on the Introduction and Improvement of Machinery.** [From the London Mechanics' Magazine.]

As hostility to machinery is a very prevalent feeling among the working classes, it might be supposed that they would turn all the power of their Unions towards its suppression. In this attempt, however, they have been singularly unsuccessful; and so far have they been from attaining, or even approaching the attainment of this object, that their efforts have led to an actually contrary result, and some of the most valuable and ingenious machines that our manufactories can boast of, actually owe their existence to the operation of Trades' Unions.

The cotton trade affords one remarkable instance of the truth of this observation. The evils inflicted on this manufacture by strikes have been detailed; many years ago the masters, with the view of escaping these disastrous effects of the tyranny of the Spinners' Union, requested the machine makers to attempt the construction of a self-acting mule, that is, of a mule which should perform its work without the assistance of a spinner. For a long time the attempt was regarded as hopeless: difficulties stood in the way, which it is not easy to describe, requiring, however, all the resources of mechanical genius to surmount. But the successive efforts of mechanists have by degrees overcome every obstacle, and the skill of Mr. Roberts, an eminent machine maker, at Manchester, has brought the invention to perfection. The most extraordinany power of this machine consists in its manner of regulating the motion of the spindles, when the mule is receding to its frame; during this retrograde course, which carries the mule over the space of 4½ feet, about three times a minute, the velocity of the spindles is constantly changing, and this continues as many hours as they are filling with thread; they exhibit, to speak mathematically, a *fluxion* of movement: during no two successive portions of time, however small, is the speed the same. The machine may now be seen in action in several mills, and almost appears to realise the finest results that could be expected from human ingenuity.

The following evidence taken by the Committee of Manufactures and Commerce, which sat last session, will show the way in which the combination of the spinners is forcing the adoption of this machine. It is given by Mr. Graham, a Scotch manufacturer:

"We are paying much higher in Glasgow than they are paying in England for spinning the same numbers, and in consequence of this we have been driven to employ machines, which may supersede those men (spinners).

"Are you aware of any cotton-spinning work, where the proprietors are turning out the old machinery in consequence of the combination of the workmen, and introducing self-acting mules?—We are doing it ourselves.

"Have you adopted the self-acting mule to get rid of combinations?—Before adopting the self-acting mule, I had the plans drawn, and I called a deputation from the men in, and explained it to them, and I said, 'you drive us either to take machines, or you drive us to bankruptcy, or to stop our works; here is an order going off to Manchester for self-acting mules; we do not wish to introduce them, and we will be the last house to introduce them, if you will take the same wages that they have in Lancashire;' and they said 'It is no use, we are determined not to reduce our wages.'"

The introduction of this invention will eventually give a death-blow to the Spinners' Union, the members of which will have to thank themselves alone for the creation of this destined agent of their extinction. It is now rapidly coming into use; other advantages, besides the great one of escaping from the dictation of the workmen, are found to attend it; and in a few years the very name of working-spinners, as well as the follies and oppression of their combination, will only be found in history.

The turn-out of the Lancashire workmen in the building trade has introduced a curious application of the steam engine. This machine is now employed in some towns, instead of manual labor, in hoisting the various building materials to the top of the edifice, where they are intended to be used. The magnificent design of the Liverpool custom-house is at the present moment rising into existence by the assistance of steam. The following letter from a master builder,

* From a very interesting pamphlet just published by Messrs. Ridgway, entitled "Character, Object, and Effects, of Trade Unions," written for the purpose of demonstrating the injurious tendency of these Unions, and written, it must be confessed, with great ability; but which, it is only fair to add, contains many facts of very questionable authenticity, and calls for new laws to put down a class of associations, which, if all be true that the author asserts of them, may be safely left to work out their own downfall.

who was one of the principal sufferers in this strike, graphically describes the circumstances attending the introduction of the improvement:

"Sir,—I have much pleasure in complying with your request, and shall feel happy if any information, which I can afford, will be useful to your purpose. About two years ago, the bricklayers' laborers, whom I had at work at the new custom-house here, began to exhibit symptoms of rebellion, the building being unusually large, and requiring much work. I found that just in proportion as we were hurried, the laborers began to relax and grow careless, and sometimes did not do a sufficient quantity of work to cover their own wages. My wits were accordingly set to work to discover a remedy. I well knew that if I resorted to severe measures, a general strike would have been the consequence; but as we had on the ground, about 35 yards from the front of the edifice, a seven-horse steam engine, for the purpose of mixing up our lime and sand into mortar, and making grout, I had the shaft of the mill lengthened, and a drum fixed upon it; attached to this was a chain governed by a break, which we carried in a hollow trough under ground, and connected with a cross-beam placed upon two uprights on the top of the building. We then placed 300 bricks in a square box, slung it, and tried our engine. The bricks went up in fine style, and were received at the top by waggons placed on a light railway, furnished with cross slides, and the result was that two laborers could fill the boxes with bricks below, sling them on the chain, and two more receive them at the top, who, by the help of the railway, conveyed them (weighing 23 cwt.) to any part of the building with ease. We thus rendered useless the services of about 20 hod-carriers at once, at the cost of about £100 in machinery. The remainder of the men were for a long period quiet, and would have continued so, had not the Trades' Unions virtually compelled them to strike, many of them against their wills. The contrivance just mentioned has acted so well, that when in full work we usually send to the top of the building 16,000 bricks per diem, with 7 or 8 tons of mortar and grout, the engine all the while doing its other accustomed work. This would only pay in large buildings; in small erections the expense of fixing the machinery would be too great; but small high pressure steam engines are now made, which stand upon three feet square, consume about 1 cwt. of coal a day, and will hoist with sufficient rapidity 25 cwt. to any height, —they are also sufficiently portable to be moved about in small carts; or I am satisfied that a horse with a rope and pulley, working through a snatch block, would be cheaper and better than the old system of manual labor.

"The contractor for the stone work at the new custom-house raises all his materials by a small engine, (I think it is eight-horse power,) which cost him £150, and his other additional machinery about £200 more. He sends his stones (varying from 1 to 11 tons in weight) up to the summit with perfect ease. His engine, like ours, is stationary, and his ropes run round the building to that part where the work is proceeding; and though they are sometimes 500 feet in length, no difficulty is experienced from this cause. We send up indiscriminately, bricks, stone, iron, or timber; the engine is much more tractable and civil than the hod-men, easier managed, keeps good hours, drinks no whiskey, and is never tired. I need hardly add, that in a large building it is much cheaper, more expeditious and satisfactory, than carrying up materials on men's shoulders. The time consumed by the men in *descending*, and by the slowness of their ascent consequent on the loss of strength caused by having to overcome the gravity of their own bodies before they have strength to spare for carrying a heavy burden, makes the hod-carriers far inferior to the steam engine, more especially if we consider the constancy with which the latter works. I do not now fear a turn-out of hod-carriers, because I have proved that we can do very well without them, and I think that I now see many other modes of saving labor, which I should instantly avail myself of, were another strike to happen amongst my workmen. It is also obvious to myself, that many of the uses to which machinery is now applied may be traced to turn-outs, which, having subjected masters to inconveniences, have compelled them to scheme mechanical contrivances that otherwise would not have been thought of. Feeling that improvements in mechanism will not eventually injure the laborer, yet I would not hastily adopt such as would suddenly deprive a number of men of their subsistence, did not their own folly compel them to it. I am now quite sure that another strike or two will annihilate many hod-carriers, and brick-makers, and this principle of hoisting by stationary or moveable steam engines will no doubt be adopted for many other purposes, if the operatives in different departments endeavor to force their employers to pay a higher rate of wages than they can afford. For instance, we know that two stationary engines

at each dock, with shafts and drums running along the quays, would discharge the cargoes of all the ships, with a tenth of the porters now employed; at present I should be sorry to see it adopted, but I know before long it must be done.

"I am, sir, your very faithful servant,
"Samuel Holme.

"Liverpool, Feb. 7, 1834."

The machine lately introduced in the wool-combing business has also been alluded to; the history of its invention gives, in a short compass, a view of the process by which results of this kind are brought about. The Wool-combers' Union has been celebrated above a century, and several acts of Parliament have been passed with the object of suppressing the power which it had acquired, and exercised with the usual bad consequences. Hence, many endeavors have been made to comb wool entirely by machinery, but with very partial success, till last year, when the whole of the combers in a large factory struck, upon which the proprietors turned their attention to this machine, applied their skill and capital to its improvement, and in a short time brought it to such perfection, as completely to supersede the employment of wool-combers.* It consists of two large wheels, set with spikes, and which are made to approach and recede alternately from each other; the spokes, fellies, and axles, are all hollow, by means of which steam is kept constantly flowing through every part of the machine, like the arteries in the human body, diffusing the required warmth to every corner of the engine. This invention is now daily coming into wider use; it performs its work both better and cheaper than by the old process, and before no long period has elapsed, the trade of wool-comber, like that of cotton-spinner, will cease to exist.

Mr. Babbage, in his "Economy of Manufactures," has given two other instances of invention of modes for superseding human labor, owing to strikes among workmen; one occurred in the manufacture of gun-barrels, and the other in that of iron tubes in general; and doubtless many other cases might be found, in which a similar process had taken place.

The obvious result of this forced and premature adoption of new machinery is to displace labor with inconvenient rapidity, and instead of improvement proceeding by those gently varying gradations, which characterise its natural progress, it advances, as it were, *per saltum*, and comes upon the workman unprepared for the change which his course of life must subsequently undergo. The counter effect in retarding the improvement of machinery, sometimes caused by combinations, is so trivial as hardly to deserve mention. But whatever power they may have in this way, the end of it must be to increase still further the evil just alluded to, and to make the progress in the application of substitutes for labor more fluctuating and irregular. At one time they are unnaturally held back, at another pushed forward.

It would be a glaring absurdity to suppose that the improvement of machinery can be really hurtful to society, or lessen the demand for labor in the country which employs it, when we have the example of Manchester before us, where, within a radius of forty miles, more human beings are collected together, and substitutes for labor more extensively used, than on any other spot on earth, and where, in addition, wages are for the most part enormously high. It undoubtedly is productive of transient injury, by the displacement which it causes of manual labor in those operations to which it is applied. But this evil is trivial, if the displacement be slow, and is formidable only when it is pushed on, as in the case above mentioned, with sudden violence.

We might view these inventions with unmixed pleasure, on account of their use to society, and even—considering the force of example—without much regret for the retribution they inflict on the offenders, were it possible to put out of sight some of the evils which may for a season follow their introduction. The community certainly gains by such mechanical improvements, which, since they spring from hostility to combinations, may be considered as indirect effects of them, and form, as far as we are aware, the only benefits those bodies have bestowed upon their country, in return for the violence and oppression of which they have been guilty.

* Till within a few years of the time when this machine was introduced, it could not have been made, though it might have been imagined, and every part and principle necessary to its construction clearly and accurately described. The reason is, that the skill and nicety of execution necessary to the manufacturing of such a machine, or of any machine requiring delicate adjustments, did not exist. The principle of Bramah's press was known two centuries before its application, but was a barren truth till mechanism had advanced sufficiently to give it an existence. [See Babbage on the Decline of Science.]

New Boot-Jacks.—A London manufacturer, amongst many articles enumerated for sale, announces "Vestris' Boot-Jacks, made in *imitation of Madame V.'s leg.*" !!! A *boot-jack* in imitation of a *Lady's leg!* Can none of our fancy dealers import it (the boot-jack)? We have a strange curiosity to see it.

On a General Mean of computing Descriptive Data of Ellipsoidal Arches, with a new Theorem, and Mechanical Description of their Working Drafts.

To the Editor, &c.

SIR,—I am induced to send for the Journal the following theorem, and incidental observations, relating to the means of describing the working drafts of ellipsoidal arches, in consequence of the solution of that problem having frequently occupied the attention of the scientific engineer, and still being, I conceive, a desideratum: at least, *general* expressions possessing the simplicity desirable and even requisite for practical purposes, and furnishing rigorous results, have not yet been investigated for obtaining the pre-requisites to the description of this curve—which is perhaps the most useful and important of any which are used in the whole range of arcuation.

Although the problem is well known to be susceptible of rigorous solution, the length of the process of computation has been deemed so formidable as to induce its supersedure by mechanical processes: the distinguished Corps de Ponts et Chaussees recommend a graphic solution. This solution is objectionable from its obvious want of rigor—a sufficient objection, I apprehend, when it is considered that, in far the greater number of instances, does this curve find its application to structures involving an expenditure of thousands, and having their elegance and *stability* materially affected thereby. The process which they would have chosen in the computation, it would seem, was, and must have been, quite formidable, to have induced this justly eminent Corps to recommend this course; but with the assistance of the theorem I am about to advance, a perfect estimation of all the pre-requisites for the description of this curve, for the greatest number of centres desirable in practice, and for arches of the largest dimensions, may be achieved in a lapse of an hour or two—an interval of time which I fancy the practical engineer will admit it is often necessary to exceed in the adjustment of much more trivial matters.

The peculiar appositeness of the semi-ellipsis, both in regard to equilibration and feasibility, when compared with the full centre, or its segment, or that of the ellipsis, as well as its elegance, will secure its adoption in preference in arches of considerable span, which are not liable to the condition of sustaining much pressure at the crown, or whose situation is not peculiarly favored by nature, at most of the localities which fall within the province of the civil engineer; for, in many places, the full centre, apart from its weakness, is absolutely inadmissible; and the segment of a circle can seldom be fortified with abutments sufficiently strong and massive to resist its stupendous thrust.

The ellipsoidal arch, or l'anse de panier, which answers the conditions of the ellipsis, has superseded it, and derives its importance chiefly from the fact of its mechanical description being executed with great ease, and because it presents a ready mode of making the drafts for the voussures—of which it is a rigorous condition that the joints be normal to the curve.

It may perhaps be unnecessary to give a demonstration in detail: the mathematical reader, with the aid of a diagram, will readily comprehend and trace its successive steps. To avoid indetermination, it is however a necessary condition, that the transverse axis be the locus of the centre of the least arc, and the prolongation of the semi-conjugate be the locus of the centre of the greatest arc; that the distances from these two centres to the common centre bear a given ratio, as $\frac{m}{n}$; that the subdivisions of these two lines, made by the intersections of the radii and their prolongations, bear, among themselves, a given ratio. It has further been conventionally determined that, in general, the subdivisions of m be in the ratio of the natural numbers 1, 2, 3, 4, &c., commencing at the least arc, and those of n be equal among themselves.

Let the subdivisions, or rather intersections, of m, by the radii, commencing with the least arc, be designated by b, c, d, &c., then the proposition is,—to find upon the tranverse axis the position of the point b.

If the vertex be taken as the origin, the general equation of the abscissa for b will be

$$x = \frac{\lambda . m - \gamma . (S - n)}{\gamma - \lambda} \quad . \quad . \quad . \ (1.)$$

in which, x = abscissa; λ = semi-minor axis; γ = semi-major axis; and S = sum of the sides of the polygon formed by lines joining the centres, b, C, D, E, &c.

It is plain, from inspection, that when S is known, the whole may be considered as known. *The quantity* S *is that which it has been proposed to eliminate by construction, on account of the length and tedium of the process of computation.*

If, however, b', c', d', e', &c., represent the lesser angles formed at b, c, d, e, &c., by the radii of curvature with m, and C′, D′, E′, F′, &c., be the angular values of each sector at C, D, E, F, &c., which are equal to the differences of the former set of angles, taken in order, then I affirm that, in general, the subsequent theorem is true, viz.

$$S = \frac{1 \cdot \sin. c'}{\mathrm{Sin.}\, C'} - \frac{1 \cdot \sin. b'}{\sin. C'} + \frac{2 \cdot \sin. d'}{\sin. D'} - \frac{2 \cdot \sin. c'}{\sin. D'} +$$

$$\frac{3 \cdot \sin. e'}{\sin. E'} - \frac{3 \cdot \sin. d'}{\sin. E'} + \frac{4 \cdot \sin. f'}{\sin. F'} - \frac{4 . \sin. e'}{\sin. F'} +$$

$$\frac{5 \cdot \sin. g'}{\sin. G'}, \ \&c. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \ (2.)$$

An expression which, following a plain mathematical law, might obviously be extended, by inspection, to resolve S for an indefinite number of centres. It is a remarkable feature of this expression, that the law which it obeys

is so simple and obvious as to be easily retained by the memory, and consequently the operator has only to write it out and apply the tables at any time occasion may require its application.

It is thus observable that the 1st term $= S$, for 3 centres; the algebraic sum of the 3 first terms $= S$, for 5 centres; of the 5 first terms $= S$, for 7 centres; and, in general, if $\nu =$ number of centres, $(\nu - 2)$ terms $= S$.

Also, if R 1, R 2, R 3, &c. be the radii of each sector respectively, then $x = R\,1, =$ least radius; $x + 1$ term $= R\,2$; $x + 3$ terms $= R\,3$; . . . . . . $x + (\nu - 2)$ terms $= x + S = R\,\frac{(\nu+1)}{2} =$ greatest radius of curvature. It is possible to construct the curve without knowing any radius but the greatest; but they, as well as the *negative terms taken separately*, will be found serviceable, as checks, in fixing the position of the centres, and are estimated without any additional trouble; since being parts of S, it is only necessary to preserve the results of the separate terms in order to obtain them. Thus does a single simple expression afford *all* the data for tracing this important curve.

Although *speculatively* the expression might be simplified, in bringing the pairs of adjacent terms affected by contrary signs, to a common denominator, yet it would not be *practically* so, for it would not then be united to logarithmic computation, for which operation it has now the most convenient form. If the calculation be skilfully conducted, its valuation will be found brief and comprehensive. For eleven centres, the logs. of all the angles may be found by 10 references to the tables; and if the arithmetic complements of the logs. of their differences be taken, as also the logs. of 1, 2, ... 5, the simple addition of these logs. agreeably to the prescribed formula, with the summing of the natural numbers answering thereto, will be the only subsequent operations.

Thus, if the span of arch be 120 feet, its rise 40 feet, the numbers of centres 11, and it be determined that the ratio $\frac{m}{n} = \frac{1}{2}$, then will the position of b be indicated by the division of the semi-span in the ratio 15 : 18.71, or at 26.7 feet from the common centre; and $R\,\frac{(\nu+1)}{2} = 120$ feet $=$ span.

Whence it is inferable, that the anse de panier of 11 centres, having the ratios $\frac{m}{n}$ and $\frac{\lambda}{2\gamma}$ each $= \frac{1}{2}$, *has its greatest radius equal to the span, or that* $R\,\frac{(\nu-1)}{2} = 2\lambda$; *and thence may it be constructed without any calculation, simply from the known span and rise.*

Its Mechanical Description.—It has not, hitherto, I believe, been remarked that the anse de panier is an *involute*, the evolute of which and locus of the centres of curvature is the polygon b, C, D, E, &c., and x the radius of curvature for the vertex. Hence, the most elegant, ready, and perhaps the best, mode of describing it mechanically, after the requisite lines have been obtained as above, is,—to fix firmly, in the plane of the draft, pins at the vertices, and at each of the central points, upon either side of n, to attach a small but firm flexible wire to the centre lying upon the conjugate produced. After plying it about the polygon to b, and increasing its length by x, which will extend it to the vertex—its evolvement will trace one half. In plying the wire upon the polygon lying upon the other side of n, the other half may be traced.

Or, take the wire $= R\,\frac{(\nu+1)}{2}$, and sweeping from the crown, ply the wire about the polygon as before, for one half; returning to the crown, ply it about the symmetrical polygon on the other side of n, for the other half.

As the wire in these movements is always in the direction of the radius of curvature, or the normal, the joints are readily constructed in this mode of description.

Very respectfully,
W. M. Cushman, C. E.
Albany, May 29, 1834.

On the Probable Results of Railroads, &c.
To the Editor of the American Railroad Journal, and Advocate of Internal Improvements.

Sir,—Has it never occurred to you that the capital vested in many railroads and canals is likely, if not exceedingly profitable at the commencement, to be eventually lost, from the roads and canals being superseded by others which may be made afterwards. The great and ultimate object of these improvements is to facilitate exchanges—to cheapen and expedite transportation to and from market—as, between the great coal region, or between the great agricultural west and the best market, whether Philadelphia, New-York, or Boston. Now, if it be assumed that transportation by railroads, or by some better roads, steam being the impelling power, shall supersede, where practicable, *all other modes of locomotion*,—and I do not suspect myself of being alone in the opinion that there is no extravagance in such an assumption, particularly when we notice the progress of things in Europe—it is no more than seasonable to begin to contemplate, and try to foresee and act upon the natural and inevitable results which must follow, and to lay them before the public, that they may be fairly in view, and have proper consideration in the mind of every man, or company, when coming to a determination in regard to any proposed improvement, both as respects its location and the manner in which it shall be completed, or the amount of capital which may be safely invested in it.

The climate and productions of Europe and North America are so nearly alike, that as the state of science and the arts in these quarters of the world continues to come nearer to an equality, it is fair to conclude that the exchanges of merchandize will hardly keep pace with the increasing population of America. Still, as the condition of men is improving, and society and nations are becoming more intimate and

friendly in their relations, and curious in their inquiries, we may suppose that travel for gratification will greatly increase between the two —this is proved by the number and constant increase of fine ships as packets; and it fairly indicates, in connection with the extent to which steamboats are coming into use, and the long voyages which they occasionally make, that the time is not distant when the packet ships will be propelled by steam. No railroad can be laid across the Atlantic. It will be an object to have each of the two ports in Europe and America, from whence most of these ships may be expected to depart for the other, situated conveniently as it respects the interior parts of the country, and as near together as may be. The wearisomeness of a long sea voyage will render these considerations indispensable, and may lead to some changes not now much thought of.

But to leave this part of the subject for a while, and dwell more particularly on our own United States.

To attain the greatest rapidity of motion will always be an object of controlling importance, and therefore level regions will be greatly desirable for the location of the principal thoroughfares. The intercourse and exchanges between the north and the south must increase vastly beyond all precedent, and probably beyond all present anticipation of the most enthusiastic, for as speed of transportation increases, and the cost is reduced, the productions of each of the various climates will be vastly more consumed in the other climates; and the assumption is, that transportation by land will gradually take the place of water navigation, first, for persons travelling, and then for merchandize, and particularly on account of its expedition, safety, and regularity. This consideration is made stronger, from the fact that much of the interior, and the finest portion of North America, and that which will soon be the most productive and most densely settled, and of course require the greatest exchanges of this character, is already as near by land to the most important productions of southern climates, as it is to our eastern commercial ports. It is not too early, then, to begin the inquiry, where shall be our principal and leading roads? for it is plain that they are not yet located, and that they cannot be determined on judiciously without the most grand and enlarged views, and the most extensive and accurate surveys.

Without attempting to speak of details, which can of course be only determined by such surveys, it is pertinent, and may be profitable to notice, that the formation of the country and the condition and wants of the citizens, present and future, clearly indicate that the road already commenced at Albany must be continued without any regard to navigable waters, on the best and most level ground westward, indefinitely; That another road from Norfolk, or perhaps from Boston, must proceed southwardly over the level region, near the coast all the way, to some harbor, where a town is yet to spring up, near the south cape of East Florida, from whence there will be a busy steamboat intercourse with Havana; That a branch of this road will proceed, say from Savannah, to New-Orleans, and thence into Texas, and onward, onward; That another principal road will be from this new city on the Cape of Florida, into the great valley of the Mississippi. This brings me back to the thoughts which put me upon this essay, the errors likely to be made in the location of railroads. I perceive some are designed to communicate only between one inland water navigation and another. These may prosper long enough to refund their cost; but the day is not distant when they will have comparatively little value.

Finally, as your journal is likely to be extensively preserved for future reading and reference, and as I am an old man, and shall hardly trouble you many times more, I ask of you the further favor to record a few prophecies.

First, fresh water navigation, including that of the Mississippi and all its tributaries, will be discontinued, probably within twenty years.

Secondly, New-Orleans, and all cities in unhealthy situations, will greatly decline, and new cities and towns spring up in more healthful and advantageous situations, and that the queen of these will be somewhere at a point not yet thought of in the great valley.

And thirdly, that either Boston or Halifax is destined to take the sceptre from the highly favored city of the island.

And, to conclude, again I would most respectfully hint to the men of Boston (and for this I hope they will remember my children) two things—first, to spare no pains, nor grudge any capital, either in the location or construction of their westward and southward railroads; and secondly, to turn their attention to European steam packets on a large scale. I beg pardon: Boston folks need no hint from me on their own affairs. C. O.

Deep Creek, Sept. 5, 1833.

Railroad on the Banks of the Rhine.—By the Hague Journal, we learn that the Prince of Orange had returned on the 27th from the head-quarters of the army to the Hague, and thus, we believe, has put an end to the apprehensions which had been entertained by the Belgians that his presence there was the forerunner of an attack. M. Dedel, also, had arrived from London at the Hague. We see that the Dutch are making a rapid progress with steam-carriages, and railroads. Messrs. Stratingh and Becker have tried a steam-carriage on the common road at Groningen, and it has run through the town without inconvenience. This was the first experiment. It is expected that the machine will be improved. A railroad is to be laid down from Amsterdam, on the right bank of the Rhine, passing through Duseldor and Elberfield to Duits, opposite to the harbor of Cologne, and preparations are making for carrying it into effect. The line is marked out, and Prussia is disposed to agree to the undertaking, the principal author of which is Lieutenant Colonel Bake. The capital necessary is estimated at eleven million florins, the annual expense at 70,000 florins, and the re-

ceipt at 1,300,000 florins. Such prospects are far more useful than those marchings and countermarchings of troops of which we have of late heard so much.—[London paper.]

On the Dip and Declination of the Needle.

To the Editor, &c.

Avoylle Ferry, May 7, 1834.

Dear Sir,—The application of a manufacturer of compasses, in Birmingham, (see current volume, page 191,) calling for information of the dip and declination of the needle, and its *variations*, I think a very important inquiry. In my letter to you, (I think in November, 1832, no copy before me,) I made a similar request, which was, no doubt, overlooked, or thought chimerical. I now wish to add to the manufacturer's inquiry, that the latitude and longitude of the different places be given, and say take the variation from June to December in each year, throughout America, and bring them together: in a few years that long sought problem will be settled. With the observations and actual experiments of Capt. Ross, of the *variation of the Magnetic Needle*, every practical surveyor in the United States can, at any time, give the variation of the needle, and mariners at all times and places wherever they may happen to be.

I have made these hasty remarks since closing my letter of to-day, to give you some idea of my opinions, that you may, if you choose, make some remarks from them.

Your friend and servant,

P. G. V.

We ask the attention of those of our readers who have the means and the inclination to investigate the subject of the above communication. The result of their inquiries, when attained, will always find a place in the Mechanics' Magazine. P. G. V. will please accept our thanks especially for his duplicates.

Avoylle Ferry, on Red River, La. May 7, 1834.

To the Editor of the American Railroad Journal.

Sir,—You herewith receive the meteorological table for the month of April, 1834, regularly entered. I regret to see in the Railroad Journal, vol. 3, No. 12, that you have not received my letter of 3d January last. I now inclose you a copy of that—also, extracts from 6th December last: as they were both sent by the same mail I presume they shared the same fate. Copies of the meteorological tables for November and December are also inclosed.

Most respectfully, your obedient servant,

P. G. V.

METEOROLOGICAL RECORD, KEPT AT AVOYLLE FERRY, RED RIVER, LOU.

For the month of April, 1834—(Lat. 31.10 N., Long. 91.59 W. nearly.)

Date.		*Thermometer.*			*Wind.*	*Weather, Remarks, &c.*
1834.		Morn'g.	Noon.	Night.		
April	1	64	78	76	S	clear—ev'ng cl'dy—planted sweet potatoes—R. Riv. rising, below h. w. m.
"	2	68	83	62	calm	" — " severe storm, and rain from north—R. Riv. at a stand [2f. 9i.
"	3	58	61	59	"	cloudy—light showers all day—night clear
"	4	50	72	66	"	clear all day and night
"	5	54	72	65	"	" " "
"	6	49	71	63	"	" " "
"	7	48	74	70	"	" " " —planted S. E. field corn
"	8	52	73	68	S	cloudy all day—Red River falling
"	9	65	71	70	"	" —rain and heavy thunder from 11 A. M. and all night
"	10	60	76	72	calm	clear
"	11	64	74	64	"	"
"	12	54	75	65	"	"
"	13	56	68	62	N	cloudy—rain in the mornng—evening clear
"	14	57	72	64	calm	clear all day
"	15	54	74	70	"	" "
"	16	64	80	70	S	cloudy—rain in the morning—clear day
"	17	62	79	76	"	clear all day—commenced mowing red clover field fot hay
"	18	70	82	68	"	" —evening severe gale—rain and thunder from south-west
"	19	64	74	74	calm	cloudy—evening clear—Irish potatoes, new crop, large and fine
"	20	65	80	72	S	foggy morning—clear day
"	21	70	80	76	S—high	cloudy all day
"	22	73	80	78	"	" " —heavy thunder and rain all night
"	23	66	81	76	S—light	" —rain in morning—clear day—night calm and cloudy
"	24	70	73	69	N W	" all day—rain all night, and calm
"	25	62	63	64	N E to N	" —rain and showers all day and night
"	26	55	60	59	calm	clear—foggy morning—snap beans and peas for use
"	27	57	74	70	"	" all day
"	28	56	72	69	"	" " —planted leveed field over the river
"	29	55	80	71	"	" "
"	30	69	84	73	S	" "

Red River fell this month 1 foot 2 inches—below high water, 3 feet 11 inches.

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum *in advance*.—John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.

MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME III.] FOR THE WEEK ENDING JUNE 28, 1834. [NUMBER 6.

"The master-piece of Knowledge is to know,
But what is good, from what is good in show."—FRANCIS QUARLES.

We extract the following interesting account of the first application of steam to vessels, from the April number of the Military and Naval Magazine. The statement appears to be well vouched for, and there is little doubt of its correctness.

STEAM NAVIGATION.—It appears from a late publication, a very valuable one by the by, "Navarette's Collection of Spanish Voyages and Discoveries," that the first known experiment of propelling a vessel by *steam* was made at Barcelona, more than *eighty-five years* before the idea of procuring motion by it was first promulgated by Brancas, in Italy—more than a *century* before this agent was applied to any useful purpose by the Marquis of Worcester, in England—and nearly *three centuries* before our own Fulton, adapting and combining the invention of a number of contemporary mechanics, successfully solved the same wonderful problem. Curious as this fact may appear, it is completely established by various documents lately found in the archives of Salamancas; and is so circumstantially stated as to be incontrovertible. From these it appears that, in 1543, Blasco de Garay, a sea officer, offered to exhibit before the emperor Charles V., a machine by means of which a vessel should be made to move without the assistance of sail or oars. Though the proposal seemed extravagant, yet the man appeared to be so confident of success that the emperor ordered a commission to witness and report upon the experiment. It consisted of Don Eurique de Tolede, Don Pedro Cardona, the Treasurer Ravago, the Vice Chancellor Gralla, and many experienced seamen. The experiment was made on the 17th day of June, 1543, on board a vessel called "Trinidad," of two hundred barrels burden, which had lately arrived, laden with wheat, from Colibre. At a given moment this vessel was seen to move forward and turn about at pleasure, without sail or oar, or human agency, and without any visible mechanism *except a huge boiler of hot water, and a complicated combination of wheels and paddles.* The harbor of Barcelona resounded with plaudits, and the commissioners, who shared in the general enthusiasm, all made favorable reports to the emperor, except the treasurer Ravago. This man, from some unknown cause, was prejudiced against the inventor and his machine. He took great pains to undervalue it, stating, amongst other objections, that it could be of little use, since it only propelled a vessel *two leagues in two hours*—that it must be vastly expensive, as it was very complicated, and that there was great danger of the boiler's bursting frequently. The experiment over, Garay collected his machinery, and having deposited the wooden part in the royal arsenal, carried the remainder to his own house.

In my reading I have somewhere met with the above, which you may deem worthy of a place in your Magazine. The details may be relied on, as I made a note of them at the time in the JOURNAL OF A REEFER.

COMFORTS OF HUMAN LIFE.—The following picture is not overcharged, and might be much extended. Nearly each individual of the civilized millions that cover the earth may have the same enjoyments as if he were the sole lord of all. "A single man of small fortune may cast his looks around him, and say, with truth and exultation, I am lodged in a house that affords me conveniences and comforts, which even a king could not command some centuries ago. Ships are crossing the seas in every direction, to bring me what is useful from all parts of the earth. In China, men are gathering the tea leaf for me; in America, they are planting cotton for me; in the West Indies, they are preparing my sugar and my coffee; in Italy, they are breeding silk-worms for me; in Saxony, they are shearing the sheep to make me clothing; in England, powerful steam-engines are spinning and weaving for me, and making cutlery for me, and

pumping the mines, that minerals useful to me may be produced. I have post-coaches running day and night, on all the roads, to carry my correspondence; I have roads and canals, and bridges, to bear the fuel for my winter fire. Then I have editors and printers, who daily send what is going on throughout the world, among all these people who serve me; and in a corner of my house I have books, the miracle of all my possessions, more wonderful than the wishing cap of the Arabian tales; for they transport me instantly, not only to all places, but to all times. By my books I can conjure up before me, in vivid existence, all the great and good men of antiquity; and for my individual satisfaction. I can make them act over again the most renowned of their exploits: the orators declaim for me: the historians recite: the poets sing: and from the equator to the pole, or from the beginning of time until now, by my books I can be where I please."—[Dr. Arnott.]

[From the Lansingburgh Gazette.]

Mr. Editor,—I beg leave through the medium of your paper, briefly to notice several communications in your two last numbers, of which I have the honor to be the subject.

I utterly disavow having knowingly in my composition a particle of ingratitude; and as I have no reason to doubt that the pieces alluded to were dictated by a spirit the most friendly for my interest, I as sincerely reciprocate to them every kind feeling which grateful sympathy can dictate.

I am well aware, however, from long observation, confirmed by a good share of experience, that whoever attempts to lessen the burden of Labor, or render it more productive, by the invention of a labor-saving machine, not only sets himself up as a mark, like a man in the pillory, for men of feeling to pity, and fools to throw rotten eggs at, but puts himself upon a fair chance to end his days in a poor-house or a prison; and I have the mortification to confess that something, which I have reason to fear is a radical defect in my constitution, has placed me among that unfortunate class of beings called inventors.

But I beg leave to state, that inventors, (poor wretches,) have feelings, and sometimes even pride, as well as other people; and as I have a little share of that added to my other misfortunes, I wish those respected friends of mine to consider that it cannot but be painful to me to be exposed as an object of public sympathy. I have been foolish enough to invent some labor-saving improvements, and men have been benefitted by them who seldom thanked me, and much more seldom paid me; and it is true, I have lately invented and constructed a *steam engine*, on a plan which, whatever may be its mechanical force, will force its way into use, and will benefit the world when I am forgotten. And it is equally true, that it has found its way out of my hands, without any fair compensation; but, thank Heaven, I still enjoy health, and strength, and air, and sometimes sun-shine, as plentifully, perhaps, as if I had never invented any thing; and if Heaven will continue me these blessings, and my friends will favor me with such jobs as will occupy my time, and keep me from committing any more acts of invention, I will thank them more for such patronage than for ten times the amount in commiseration.

Simon Fairman.

Lansingburgh, June 3, 1834.

The Stature and Weight of Man at different Ages. [From Jameson's Edinburgh Philosophical Journal.]

M. Quetelet, of Brussels, has lately published* the results of his investigations on the developement of the weight of man, his growth, his inclination to crime, the succession of generations, &c. He proposes, hereafter, to publish new inquiries concerning the strength, swiftness, and other qualities of the human species: inquiries which, in order to be exact, must be made by many associated observers, and upon a great number of individuals.

The observations of M. Quetelet were made at Brussels, in the Maternal Hospice of St. Peter. He compares them with those made at Moscow and Paris, in similar hospices, and he finds little difference between the means obtained. Unfortunately, the Russian and French practitioners have not distinguished, with as much care as M. Quetelet, the sex, the stature, and the weight of children observed at their birth. This renders the results less capable of minute comparison.

M. Quetelet found for 63 male children, and 56 female, newly born, the following quantities:

	Weights.	*Stature.*
Male children,	7·057536 lbs. avoird.	1·62732 imperial feet.
Female,	6·4179486 "	1·58467 "

The extremes are:

	Boys.	*Girls.*
Minimum,	5·1606838 lbs.	2·4701378 lbs.
Maximum,	9·92466 "	9·936685 "

The mean weight, without distinction of sex, is 6·7377414 lbs. avoird. It has been found at Paris on 20,000 observations, 6·74656332 lbs. avoird.

M. Quetelet has made similar inquiries concerning children from 4 to 12 years of age, in

---

* A pamphlet in 4to, pp. 43. Brussels, 1833. Translated by the Rev. W. Ettershank.

the schools of Brussels and in the orphan hospital—concerning young people in the colleges and in the medical school—finally, concerning old men in the magnificent hospice which has been constructed in the same city for a period of four years. The results have been completed by observations made upon isolated individuals, taken by chance from the mean of all these *data*. M. Quetelet does not consider the results obtained in hospitals and public schools to be very exact as to the mean stature of the population, because inquiries made by him, concerning a great number of individuals, have proved to him that the mean stature is a little more among individuals in easy circumstances, than in the indigent population, who have recourse to hospices, hospitals, and gratuitous schools. The following table, which we may consider as exact for the whole population of Brussels, and which, for want of a table of this sort, calculated for other countries, may serve, at least, as an approximation for the Caucasian race, and in a temperate climate.

A Scale of the Developement of Stature and Weight.

YEARS.	MALES.		FEMALES.	
	Stature.	*Weight.*	*Stature.*	*Weight.*
	Imp. ft.	lbs. avoir.	Imp. ft.	lbs. avoir.
0	1 64045	7.05736	1.60764	6.4179408
1	2.29067	20.841786	2.26362	19.3861692
2	2.59519	25.0191438	2.56126	23.5394716
3	2 83409	27.5023336	2.79538	26.0098092
4	3.04468	31.3659604	3.00198	28.67194
5	3.24153	34.7804194	3.19559	31.6706928
6	3.43511	38.7068738	3.36961	35.98768
7	3.62539	42.984108	3.56305	38.6841192
8	3 81940	45.7857648	3.74351	42 0805584
9	3.99042	49 954122	3.92067	47.1040998
10	4.18314	54.0783606	4.09457	51.8792690
11	4.3636	59.768508	4.26180	56.570508
12	4.54404	65.7874136	4 43905	65.7874136
13	4.72123	75.8944094	4.60310	72.6485112
14	4.89838	85.4844046	4.76714	80.941116
15	5.07237	93.0974 5694	4 91807	89.025276
16	5.22975	109.5461916	5.03618	96.0027636
17	5.36089	116 589618	5 10179	104.3419588
18	5.43973	127.587013	5.13138	112.5456444
20	5 49922	132.4611968	5.15757	115.3094040
25	5.51191	138.7909064	5.17386	117.5979744
30	5.52503	140.378602	5.18054	119.8937284
40	5.52503	140.4990116	5.18054	121.8080804
50	5.49922	139.9597608	5.02946	123.9097568
60	5.37740	136.074312	4.97384	119.757364
70	5.32400	131.2701696	4.96738	113.6048748
80	5.22819	127.5490084	4.84103	108.884576
90	5.22819	127.5490084	4.93775	108.8169092

We see from this table, 1st, that at an equality of age the male is generally heavier than the female—towards the age of 12 years only, an individual of either sex has the same weight. 2dly, That the male attains the maximum weight about the age of 40 years, and that he begins to lose, in a very sensible manner, towards his 60th year—that at the age of 80 years he has lost about 13·23298 lbs. avoird., the stature being also diminished 2·75604 inches. 3dly, That the female attains the maximum weight later than the male, towards the 50th year. 4thly, That when the male and female have assumed their complete developement, they weigh almost exactly 20 times as much as at the moment of their birth, while their stature is only about 3¼ beyond what it was at the same period. Children lose weight during the first 3 days after their birth; at the age of a week, they begin sensibly to increase; after 1 year, they have tripled their weight; then, they require six years to double the weight of 1 year, and 13 to quadruple it.

To calculate the burden of an edifice, or a bridge, covered with a crowd, it is well to know that the mean weight of an individual, whatever is the age or sex, is about 98·584956 lbs. avoird.; that is, 103·65756 lbs. for the males, and 93·7328 lbs. for the females.

The inferior parts of the body are developed more than the superior. In a child the head is equal to a fifth part, and in a full-grown man to an eighth of the whole height of the individual. These proportions vary a little among different nations. D.

April 2.

MEMOIR OF LAFAYETTE.

Lafayette, Gilbert Motier, (formerly Marquis de,) was born at Chavagnac, near Brioude, in Auvergne, September 6, 1757, was educated in the college of Louis le Grand, in Paris, placed at court, as an officer in one of the guards of honor, and, at the age of 17, was married to the grand-daughter of the duke of Noailles. It was under these circumstances that the young Marquis de Lafayette entered upon a career so little to be expected of a youth of vast fortune, of high rank, of powerful connections, at the most brilliant and fascinating court in the world. He left France secretly for America, in 1777, and arrived at Charleston, South Carolina, April 25, being then 19 years old. The state of this country, it is well known, was, at that time, most gloomy; a feeble army, without clothing or arms, was with difficulty kept together before a victorious enemy; the government was without resources or credit, and the American agents in Paris were actually obliged to confess that they could not furnish the young nobleman with a conveyance. "Then," said he, "I will fit out a vessel myself;" and he did so. The sensation produced in this country, by his arrival, was very great; it encouraged the almost disheartened people to hope for succor and sympathy from one of the most powerful nations in Europe. Immediately on his arrival, Lafayette received the offer of a command in the continental army, but declined it, raised and equipped a body of men at his own expense, and then entered the service as a volunteer, without pay. He lived in the family of the commander-in-chief, and won his full affection and confidence. He was appointed major-general in July, and in September was wounded at Brandywine. He was employed in Pennsylvania and Rhode Island in 1778, and, after receiving the thanks of the country for

his important services, embarked at Boston, in January, 1779, for France, where it was thought he could assist the cause more effectually for a time. The treaty concluded between France and America, about the same period, was, by his personal exertions, made effective in our favor, and he returned to America with the intelligence that a French force would soon be sent to this country. Immediately on his arrival, he entered the service, and received the command of a body of infantry of about 2,000 men, which he clothed and equipped, in part, at his own expense. His forced march to Virginia, in December, 1780, raising 2,000 guineas at Baltimore, on his own credit, to supply the wants of the troops; his rescue of Richmond; *his long trial of generalship with Cornwallis*, who boasted that "the boy could not escape him;" the siege of Yorktown, and the storming of the redoubt, are proofs of his devotion to the cause of American independence. Desirous of serving that cause at home, he again returned to France for that purpose.

Congress, which had already acknowledged his merits on former occasions, now passed new resolutions, (November 23, 1781,) in which, besides the usual marks of approbation, they desired the American ministers to confer with him in their negociations. In France, a brilliant reputation had preceded him, and he was received with the highest marks of public admiration. Still he urged upon his government the necessity of negociating with a powerful force in America, and succeeded in obtaining orders to that effect. On his arrival at Cadiz, he found 49 ships, with 20,000 men, ready to follow him to America, had not peace rendered it unnecessary. A letter from him communicated the first intelligence of that event to Congress. The importance of his services in France may be seen by consulting his letters in the correspondence of the American Revolution, (Boston, 1831.) He received pressing invitations, however, to revisit the country. Washington, in particular, urged it strongly; and, for the third time, Lafayette landed in the United States, August 4, 1784. After passing a few days at Mount Vernon, he visited Baltimore, Philadelphia, New-York, Boston, &c., and was every-where received with the greatest enthusiasm and delight. Previous to his return to France, Congress appointed a deputation, consisting of one member from each state, "to take leave of him on behalf of the country, and assure him that the United States regard him with particular affection, and will not cease to feel an interest in whatever may concern his honor and prosperity." After his return he was engaged in endeavoring to mitigate the condition of the Protestants in France, and to effect the abolition of slavery. In the Assembly of the Notables, in 1787, he proposed the suppression of *lettres de rachet*, and of the state prisons, the emancipation of the Protestants, and the convocation of the representatives of the nation. When asked by the Count D'Artois, since Charles X., if he demanded the states-general—"Yes," was his reply, "and something better." Being elected a member of the states-general, which took the name of *national assembly*, (1789,) he proposed a declaration of rights, and the decree providing for the responsibility of the officers of the crown. Two days after *the attack on the Bastile*, he was appointed, (July 15,) commander-in-chief of the national guards of Paris. The court and national assembly were still at Versailles, and the population of Paris, irritated at this, had already adopted, in signs of opposition, a blue and red cockade, (being the colors of the city of Paris.) July 26, Lafayette added to this cockade the white of the royal arms, declaring at the same time that the tri-color should go round the world. On the march of the populace to Versailles, (October 5 and 6,) the national guards claimed to be led thither. Lafayette refused to comply with their demand, until, having received colors in the afternoon, he set off, and arrived at 10 o'clock, after having been on horseback from before daylight. He requested that the interior of the *chateau* might be committed to him; but this request was refused, and the outer posts only were entrusted to the national guards. This was the night on which the assassins murdered two of the queen's guards, and were proceeding to further acts of violence, when Lafayette, at the head of the national troops, put an end to the disorder, and saved the lives of the royal family. In the morning he accompanied them to Paris.

On the establishment of the Jacobin club at Paris, he organized, with Bailly, then Mayor of Paris, the opposing club of Feuillans. January 20, 1790, he supported the motion for the abolition of titles of nobility, from which period he renounced his own, and has never since resumed it. The constitution of a representative monarch, which was the object of his wishes, was now proposed, and July 13, 1790, was appointed for its acceptance by the king and the nation, and in the name of 4,000,000 national guards, Lafayette swore fidelity to the constitution. Declining the dangerous power of constable of France, or generalissimo of the national guards of the kingdom, after having organized the national militia, and defended the

king from popular violence, he retired to his estates. The first coalition against France, (1792,) soon called him from his retirement. Being appointed one of three major-generals in the command of the French armies, he established discipline, and defeated the enemy at Phillipville, Maubeuge, and Florennes, when his career of success was interrupted by the domestic factions of his country. Lafayette openly denounced the terrible Jacobins, in his letter of June 19, in which he declared that the enemies of the revolution, under the mask of popular leaders, were endeavoring to stifle liberty under the excesses of licentiousness. June 20, he appeared at the bar of the assembly, to vindicate his conduct, and demand the punishment of the guilty authors of the violence. But the mountain had already overthrown the constitution, and nothing could be effected. Lafayette then offered to conduct the king and his family to Compiegne. This proffer being declined, he returned to the army, which he endeavored to rally round the constitution. June 30, he was burnt in effigy at the Palais Royal; and August 5, was accused of treason before the assembly. Still he declared himself openly against the proceedings of August 10; but, finding himself unsupported by his soldiers, he determined to leave the country, and take refuge in some neutral ground. Some persons have charged General Lafayette with a want of firmness at this period, but it is without a full understanding of the situation of things. Conscious that a price was set on his head at home, knowing that his troops would not support him against the principles which were triumphing in the clubs and the assembly, and sensible that, even if he were able to protract the contest with the victorious faction, the frontiers would be exposed to the invasion of the emigrants and their foreign allies, with whom he would have felt it treason against the nation to have negociated, he had no alternative. Having been captured by an Austrian patrol, he was delivered to the Prussians, by whom he was again transferred to Austria. He was carried, with great secrecy, to Olmutz, where he was subjected to every privation and suffering, and cut off from all communication with his friends, who were not even able to discover the place of his confinement until late in 1794.

An unsuccessful attempt was made to deliver him from prison by Dr. Bollman, a German, and Mr. Huger, (now Colonel Huger, of Charleston, S. C.) His wife and daughters, however, succeeded in obtaining admission to him, and remained with him nearly two years, till his release. Washington had written directly to the Emperor of Austria on his behalf, without effect; but after the memorable campaign of Bonaparte in Italy, the French government required that the prisoners at Olmutz should be released, which was done August 25, 1797, after a negociation that lasted three months. Refusing to take any part in the revolutions of the 18th Fructidor, or of the 18th Brumaire, he returned to his estate at La Grange, and, declining the dignity of senator, offered him by Bonaparte, he gave his vote against the consulate for life, and, taking no further part in public affairs, devoted himself to agricultural pursuits. On the restoration of the Bourbons, in 1814, he perceived that their principles of government were not such as France required, and he did not therefore leave his retirement. The 20th March, 1815, again saw Napoleon on the imperial throne, and endeavoring to conciliate the nation by the profession of liberal principles. Lafayettee refused, though urged though the mediation of Joseph, to see him, protested against the *acte additionnel* of April 22, declining the peerage offered him by the Emperor, but accepted the place of representative, to which the votes of his fellow-citizens called him. He first met Napoleon at the opening of the chambers: the Emperor received him with great marks of kindness, to which, however, he did not respond; but, although he would take no part in the projects of Napoleon, he gave his vote for all necessary supplies, on the ground that France was invaded, and that it was the duty of all Frenchmen to defend their country. June 21, Napoleon returned from Waterloo, and it was understood that it was determined to dissolve the house of representatives, and establish a dictatorship. Two of his counsellors informed Lafayette that, in two hours, the representative body would cease to exist. Immediately on the opening of the session, he ascended the tribune, and addressed the house as follows: "When, for the first time, after an interval of many years, I raise a voice which all the old friends of liberty will recognise, it is to speak of the danger of the country, which you only can save. This, then, is the moment for us to rally round the old tricolored standard, the standard of '89, of liberty, of equality of public order, which we have now to defend against foreign violence and usurpation." He then moved that the house declare itself in permanent session, and all attempts to dissolve it high treason; that whoever should make such an attempt should be considered a traitor to the country, &c. In the evening, Napoleon sent Lucien to the house, to make one more effort in his

favor. Lucien, in a strain of impassioned eloquence, conjured the house not to compromise the honor of the French nation by inconstancy to the Emperor. At these words, Lafayette rose in his place, and addressing himself directly to the orator, exclaimed, "Who dares accuse the French nation of inconstancy to the Emperor? Through the sands of Egypt and the wastes of Russia, over fifty fields of battle, this nation has followed him devotedly, and it is for this that we now mourn the blood of three millions of Frenchmen." This appeal had such an effect on the assembly, that Lucien resumed his seat without finishing his discourse. A deputation of five members from each house was then appointed to deliberate in committee with the council of ministers. Of this deputation, General Lafayette was a member, and he moved that a committee should be sent to the Emperor to demand his abdication. The arch-chancellor refused to put the motion; but the Emperor sent in his abdication the next morning, (June 22.)

A provincial government was formed, and Lafayette was sent to demand a suspension of hostilities of the armies, which was refused. On his return, he found Paris in possession of the enemy; and, a few days after, (July 8,) the doors of the representatives' chamber was closed, and guarded by Prussian troops. Lafayette conducted a number of the members to the house of Lanjuinais, the president, where they drew up a protest against this act of violence, and quietly separated. Lafayette now retired once more to La Grange, where he remained to 1818, when he was chosen member of the Chamber of Deputies. Here he continued to support his constitutional principles, by opposing the laws of exceptions, the establishment of the censorship of the press, the suspension of personal liberty, &c., and by advocating the cause of public instruction, the organization of a national militia, and the inviolability of the charter. In June, 1824, he landed at New-York, on a visit to the United States, upon the invitation of the President, and was received in every part of the country with the warmest expressions of delight and enthusiasm. He was proclaimed, by the popular voice, "the guest of the nation," and his presence every where was the signal for festivals and rejoicings. He passed through the twenty-four states of the Union in a sort of triumphal procession, in which all parties joined to forget their dissensions, in which the veterans of the war renewed their youth, and the young were carried back to the doings and sufferings of their fathers. Having celebrated, at Bunker Hill, the anniversary of the first conflict of the revolution, and, at Yorktown, that of its closing scene, in which he himself had borne so conspicuous a part, and taken leave of the four ex-Presidents of the United States, he received the farewell of the President, in the name of the nation, and sailed from the capital in a frigate, named, in compliment to him, the Brandywine, September 7, 1825, and arrived at Havre, where the citizens, having peaceably assembled to make some demonstrations of their respect for his character, were dispersed by the *gend'armerie*. In December following, the Congress of the United States made him a grant of $200,000, and a township of land, "in consideration of his important services and expenditures during the American revolution." The grant of money was in the shape of stock, bearing interest at six per cent., and redeemable December 31, 1834. In August, 1827, he attended the obsequies of Manuel, over whose body he pronounced a eulogy. In November, 1827, the Chamber of Deputies was dissolved. Lafayette was again returned a member by the new elections. Shortly before the revolution of 1830, he travelled to Lyons, &c., and was enthusiastically received—a striking contrast to the conduct of the ministers towards him, and an alarming symptom to the despotic government. During the revolution of July, 1830, he was appointed general-in-chief of the national guards of Paris, and though not personally engaged in the fight, his activity and name were of the greatest service.

To the Americans, Lafayette, the intimate friend of Washington, had appeared in his last visit almost like a great historical character returning from beyond the grave. In the eyes of the French, he is a man of the early days of their revolution—a man, moreover, who has never changed side or principle. His undeviating consistency is acknowledged by all, even by those who did not allow him the possession of first-rate talents. When the national guards were established throughout France, after the termination of the struggle, he was appointed their commander-in-chief, and his activity in this post was admirable. August 17, he was made marshal of France. His influence with the government seems to have been, for some time, great; but whether his principles were too decidedly republican to please the new authorities, (a few days after the adoption of the new charter, he declared himself a pupil of the American school,) or whether he was considered as the rallying point of the republican party, or whatever may have been the reason, he sent his resignation in December, 1830, which was accepted, and Count Lobau

appointed chief of the national guards of Paris. Lafayette declared from the tribune, that he had acted thus in consequence of the distrust which the power accompanying his situation seemed to excite in some people. On the same occasion he also expressed his disapprobation of the new law of election. Shortly before his resignation, he exerted himself most praise-worthily to maintain order during the trial of the ex-ministers. The Poles lately made him first grenadier of the Polish national guards. We are unable to state what were Lafayette's views respecting the best government for France in its present condition, though undoubtedly, in its abstract, he preferred a republic.

Thus far we have extracted from the 'Encyclopædia Americana." Little occurred of public interest with which he was connected during the remainder of his life. About eight months since, it was evident to himself and many of his relatives and friends, that he was fast declining in health; and on the 20th May he closed his earthly career, in the full possession of all his faculties. On the intelligence reaching this country, it was received with feelings of deep sorrow, and preparations were immediately made to show all due honor to his memory. On the 26th of June, a funeral procession was formed in the city of New-York, and "it," says the Journal of Commerce, "may be emphatically said, that almost the entire city was arrayed in mourning. The day was ushered in with long continued discharges of artillery, which were repeated at intervals during the day. The national flag, covered entirely or in part with black, was hoisted on all the public and an immense number of private buildings, in different parts of the city. All the ships in port had their colors at half mast, from sunrise till evening. Every person connected with any of the public bodies of the city, and a large number of private citizens, wore black crape on the left arm, or emblematic insignia on their bosoms, commemorative of the deceased. Among the most tasteful of these, was a small bust of Lafayette, (printed on silk,) with the genius of America weeping over it. This insignia was worn by an immense number of people. About half past three o'clock, the procession began to move from the Park, at which moment the bells commenced tolling, and continued till the ceremonies had closed—about three hours and a half. When the several public bodies and parties of military had taken their stations, the procession formed a column six deep, extending up Chatham street to the Bowery, up the Bowery to Broome street, through Broome street to Broadway, and down Broadway to the Park, a distance of at least two miles, so that when the van arrived opposite the Park on their way to Castle Garden, the rear had not left it."

The following was the order of the Procession:

Grand Marshal of the day.
The Military under the command of Major General Morton.
The Reverend the Clergy.

A Charger appropriately caparisoned, with mourning trappings.

A FUNERAL URN,

surmounted by the American Eagle, and covered with black crape, drawn on a car by four grey horses.

The Lafayette Guards, acting as a Body Guard.

Pall Bearers in Carriages, viz.:

1. Major General Morgan Lewis—President of the New-York State Society of Cincinnati; Deputy Quarter-Master General of the Northern Department of the Continental Army.
2. Colonel John Trumbull—Vice-President of the Society; Deputy Adjutant General of the same Department of the Army.
3. Colonel Simeon Dewitt—Surveyor General of the State, Geographer to the Continental Armies.
4. Major Samuel Cooper—of the 3d Massachusetts regiment of the line of the Continental Army.
5. Colonel William North—Aid-de-camp to Major General the Baron Steuben.
6. Major William Popham—Aid-de-camp to General George Clinton, (afterwards Governor of this State, and Vice-President of the United States.)
7. Colonel John Van Dyk—Captain in Colonel Lamb's regiment of Artillery in the line of the Continental Army.
8. Captain Nathaniel Norton—of the 4th New-York regiment in the line of the Continental Army, (the oldest member of the Society, now in his 93d year.)

Mayor of the City, and Orator of the day,
The Hon. James Tallmadge.
The Common Council of the city of New-York, as mourners, in the following order, viz.:
The Board of Aldermen, headed by their President,
The Board of Assistants,
The Officers of both Boards,
The Ex-Mayors, Ex-Aldermen, and Ex-Assistant Aldermen.
Mayor and Common Council of the City of Brooklyn.
Society of the Cincinnati.
Consul of France and the French Residents
The Judges of the U. States, State, and City Courts, and the Recorder.
Members of the Senate and State Legislature.
Foreign Ministers and Consuls.
Grand Lodge of the State of New-York.
Members of the Bar.
Marshal of the United States and Sheriff of the City.
Register, County Clerk, and Coroner.
Officers of the Army and Navy of the United States.
Military Officers off duty.
The President, Trustees, Faculty, and Students of Columbia College.
The President, Faculty, and Students of the University.
College of Physicians and Surgeons.
Chamber of Commerce.

Board of Trade.
Officers of the Customs.
Wardens of the Port and Harbor Masters.
Marine Society.
Fire Department of the City of New-York,
Brooklyn, and Haerlem.
The Trades Union Societies in the following order:
Block and Pump Makers,
Sail Makers,
Journeymen Tailors of Brooklyn,
Bakers of New-York,
ourneymen Brass Founders,
Grate and Fender Makers,
Cabinet Makers,
Granite Stone Cutters,
Cordwainers, Ladies' Branch,
Plane Makers,
Book Binders,
Rope Makers of Brooklyn,
Tin Plate and Sheet Iron Workers,
Leather Dressers' Society,
Stone Cutters,
Brush Makers,
Printers,
Coopers,
House Carpenters,
Chair Makers,
Tailors,
Coopers of Brooklyn,
Silk Hatters,
and
The Hibernian Provident Society.
The Hibernian Benevolent Society.
Citizens of Brooklyn.
Citizens of New-Jersey.
Citizens of New-York.

A vast multitude filled the houses and balconies, and lined the way along the streets through which the procession was to pass. The procession reached Castle Garden about six o'clock, and by half past six as many had entered it as could find admission, including none of the military except the Lafayette Guards. The exercises commenced by singing "Unveil thy bosom, faithful tomb," in the Dead March in Saul; after which Bishop Onderdonk read the funeral service, commencing with the 15th chapter and 20th verse of Paul's epistle to the Corinthians. Other hymns were also sung during the performance of the service, after which James Tallmadge, Esq. Orator of the Day, commenced the funeral oration, as follows:

"Could I imbibe inspiration from my subject, or were my powers equal to my wishes, you would not have any reason to regret my having consented to appear before you on this painfully interesting occasion. Sensible of the magnitude of the duty imposed on me, I did not, however, consider myself at liberty to refuse complying with the request of our city authorities, to deliver an address concerning him to whom we owe so large a debt of gratitude. We have assembled here this day by one common impulse,—under the municipal authorities, and in presence of the clergy, the official representatives of our colleges and universities, the learned societies, the society of Cincinnati, the military, and the charitable and mechanical institutions of our city, to bear our part in the general mourning commemorative of the death of our most illustrious citizen.

"Lafayette is no more—our friend and benefactor is departed. On the morning of the 20th of May, his earthly career closed for ever, and his spirit took its flight to another, and a better world. In order to properly appreciate the conduct and character of such a man, and estimate his public services, and the many obligations and extent of gratitude we owe him, for benefits so signally conferred, it is necessary to recollect the era in which he lived, and the circumstances under which he acted. If we have recourse to the page of history, and peruse the lessons of civil and religious experience, they present to our view but gloom and darkness,—a continued tale of outrage on all the rights and liberties of mankind,—an atrocious tyranny of the few over the lives and fortunes of the many. Centuries rolled away, during which universal despotism with iron sceptre swayed the civilized world. Man lay degraded, dishonored, and abused; learning was banished from the earth, or locked up in cloistered cells; civil liberty was unknown, and ecclesiastical tyranny triumphed over a prostrate world bound down with the chains of a superstitious discipline. The genius of a great reformer, however, unloosed the cords of oppression, broke the bonds of ecclesiastical tyranny, and burst asunder the shackles of superstition. The world was taught to think; the human mind became enlightened; and mankind stood redeemed and regenerated, and consummated that glorious reformation, the blessed fruits of which we enjoy at present. Civil and religious liberty was however as yet only in its infancy; and, in the middle of the last century, great oppressions elicited an ebullition, which, like the dove from Noah's ark, regained no resting place. Then it was that this New World, burning with the flame of light and liberty, determined to be free. The Congress of 1776 was called together, and declared this nation independent. They called on the country to work out its own regeneration; and though fearful was the struggle, they relied upon the justness of their cause, and trusted in God for a successful issue. From that struggle we came forth an independent people, and we are now called to mourn for the patriot who united with our fathers in achieving so great a triumph."

The speaker then took a cursory view of Lafayette's life, and concluded by expressing a hope that the remains of Lafayette would finally repose in this country.